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Report numbers, which were not dropped in abstract citations, can in most cases provide sufficient information to determine corporate sources.

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Volume 3, Number 4, February 28, 1978

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 8231, 8595

7799 (ARP—31) **Statement on some research priorities in coal.** Moore, J.R. (Tennessee Univ., Knoxville (USA). Dept. of Economics). 27 Feb 1975. 13p. of Tennessee, Appalachian Resources Project, Knoxville.

For House of Representatives, Committee on Science and Technology, Subcommittee on Fossil Fuels.

Recommendations for research programs in the coal industry include: Research in extraction methods (development and testing of new methods of surface mining and land reclamation); requirement of an overall systems model of coal extraction (including environmental effects); specific data requirements; study of coal industry structure and organization; possible industry constraints (uncertainty with respect to reclamation regulations, water discharge standards, sulfur emission standards, availability of transport, etc.); problems, mainly economic, with respect to coal conversion, especially if many large plants are built, etc. (LTN)

7800 (FE—2468-9) **ESCOE engineering program. Quarterly report, March 1, 1977—May 31, 1977.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, D.C. (USA)). Aug 1977. Contract EF-77-C-01-2468. 9p. Dep. NTIS, PC A02/MF A01.

The objectives of this program are to conduct independent studies and to provide technical assistance to the Fossil Energy Office of Program Planning and Analysis. To achieve this objective ESCOE will utilize a team of experienced engineers and scientists who come from the academic, industrial, and technical communities and who have significant experience in energy development and utilization. These principal research personnel will be assigned for a temporary period of about two. years and will be replaced by similarly qualified people to insure that current technical information and knowledge is available to ERDA. Work assignments will be performed pursuant to tasks developed by the technical representative from ERDA with the assistance of the Program Manager from ESCOE. Each work assignment will be specific as to the work to be performed and the date of completion.

7801 **Position of the power industry.** *Konjunkturber.;* **27**: No. 3, 31-44(1976). (In German).

With figs. and tabs.

The situation on the pit coal market is characterized by the stagnating consumption; inland marketing and export are livening up, but the import has further risen. For 1976 one can only reckon with a market of 81-82 million t. of usuable haulage so that with a probable haulage of 89 million t, the mining stocks further increase. Consumption and marketing of heating oil are recurrent with slight increased refinery production; the import of heavy heating oil has maintained last year's level, but is below that of light heating oil. The expansion of matural gas has slowed down while in the consumption and demand of other gases the weakening trends prevailed. The current consumption from the public network was 9% higher than last year in the period from January to September 1976.

PROCESSING

REFER ALSO TO CITATION(S) 9028

7802 **Coke manufacture--metallurgical coke, foundry coke, molded coke.** (Inst Fr de Pet). *Ind. Miner. (St.-Etienne, Fr.) ;* **59**: No. 2, 99-101(Feb 1977).

The author discusses the principles of coke manufacture. the requirements for metallurgical coke, as well as the required quantities of coking coal, Information is then presented on foundry coke and chemical coke. Finally, reference is made to molded coke and various manufacturing processes for this new product.

7803 **Applications of fluidized beds in coal technology.** Squires, A.M. (City Coll, New York). pp 59-109 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

The various flow regimes in fluidized beds are described, depending on the particle size, fluid (liquid or gas) and velocity. The potential value of fast fluidized beds by way of greater throughput with smaller reactors is stressed. The relatively high heat transfer and improved reactivity in such beds are emphasized. Finally, various applications are described: Fluidized-bed combustion of coal combined with desulfurization with dolomite, shallow beds, coal gasification, fast fluidized bed reactors, etc. (LTN)

CARBONIZATION

7804 **Reactivity of heat-treated coals in hydrogen.** Tomita, A.; Mahajan, O.P.; Walker, P.L. *Fuel;* **56**: No. 2, 137-144(Apr 1977).

Reactivities of eighteen 40x 100 mesh U.S. coals charred to 1000°C have been measured in H_2 at 2.7 MPa and 980°C. The char-hydrogen reaction usually occurs in two stages: a slow induction period followed by a constant-rate region. Reactivities of various chars in the initial stage (Ri) decrease, in general, with increasing carbon content of the parent coals, whereas reactivities in the constant-rate region (Rc) are essentially independent of the rank of the parent coals. Reactivities of chars in H_2 differ markedly from those in air and CO_2. Results of surface-area measurements of chars and activation energies for the hydrogasification reaction suggest that during the induction period the reaction is diffusion-controlled whereas in the constant-rate region it is chemically controlled. Upon removal of mineral matter, Ri values generally decrease but Rc values show a random variation. Removal of mineral matter from coals prior to their carbonization brings about profound changes in surface area and porosity of chars. The effect of char particle size on reactivity is considered.

7805 **Mechanical treatment of coke and its effect on properties.** Muchnik, D.A. *Koks Khim.;* No. 11, 20-23(Nov 1976).

A test charge was composed of 31% gas coal, 32% fat, 19% coking and 18% high-coking coal, 75 to 78% sized 3 mm and below, using coking times of 24, 20, 16, 15h. In drum tests it was found that the coking period has little effect on the 60 to 80 mm size range, though with the shorter coking times there was a larger amount of 25 to 40 and 40 to 60 mm but less 80 mm and above. The main advantage of the longer coking periods is the greatly improved and standardised strength right through the individual coke pieces.

7806 **Computing coking times.** Frumkin, V.M. *Koks Khim.;* No. 11, 12-15(Nov 1976).

A nomogram was produced involving bulk density of moist charge, wall thickness, thermal capacitance of charge, thermoconductivity of the walls, oven width, cake temperature and discharge temperature, as well as wall temperature during coking. Ways of reducing coking time are: by raising the temperature in the flues; by using a narrower oven; by adopting lower bulk density charges and finally by employing more conductive refractories for firebricks.

7807 **How caking capacity and rank affect coke yields.** Sheikhet, A.M. *Koks Khim.;* No. 9, 21-24(Sep 1976).

The relationship between coke yield and the volatile matter of the charge is discussed. Using a ratio described as F:G (fat:long flame gas), the authors state that as this increases, so does the coke yield and an expression is given which relates the coke yield to this rank index. However, to compute the coke yield from charges for

which the F:G ratio is close or even the same, a more sensitive index is needed and the authors suggest the dilatometric indices which reflect changes in rank and are capable of differentiating between the properties of coals within one particular rank group. Thus knowing the relationship between the rank structure of coal (F:G), the coke yield and the effect that the dilatometric indices have on the direction of change of the properties of the plastic mass, the authors suggest that the main reason underlying an additional yield of coke is the caking capacity of the charge.

7808 Research position and technological level decisions with regard to the pre-heating of the charge. Vasil'ev, Yu.S. *Koks Khim.;* No. 9, 51-52(Sep 1976).

Indications are that pre-heating the charge considerably enlarges the raw material base available to the coking industry by enabling larger amounts of lower rank coal to be included in the charge. There is evidence also of considerable improvements in mechanical strength of coke obtained from a pre-heated charge. Yields of foundry coke are increased by 1.5 to 2% when charges are pre-heated and the oven throughput can be raised by 40 to 50% by increasing the bulk mass of the charge and reducing the coking period. A Giprokoks project involved 150 to 180 C single-stage heating or two-stage to 250 C. Pre-heating is carried out at the end of the battery in a small enclosure. A major difficulty arises during charging because of dust in the flues. The two Soviet charging methods are wagon and blow-lining. In the wagon method, charge is drawn off at both ends and gas exhausted from the centre hatch. The pneumatic method, blow-lining, is still in the experimental stage at Donetsk coking plant.

7809 Reasons underlying sluggish cake pushing movement. Bronnikob, V.K.; Nazarenko, B.G. *Koks Khim.;* No. 9, 28-29(Sep 1976).

The need for a higher pushing force, and sometimes even drilling out, was occasioned chiefly by variations in the quality of the coal charge, generally the moisture, and possibly incomplete filling of the coal-charging tower. This must be at least two-thirds full if satisfactory charge distribution and oven-filling are to be achieved. Another reason for requiring a high pushing force was a defective refractory lining of the oven, chiefly in the form of blowholes or displacements in excess of 15 mm. Where the lining was destroyed, greater amounts of heat gained access to the coal charge with the result that there was a general loss of integrity in the coke cake in this region. Attempts to overcome this concentrated chiefly on guniting of the defective points. It was also found that there was a considerable reduction in pushing force required when the coking period was extended by 15 or 30 minutes.

7810 Coking at elevated flue temperatures. Kunc, J.; Heppner, P. *Sb. Pr. UVP;* No. 32, 1-54(1976).

Paper describes pilot and full-scale experiments on coking of charges to produce metallurgical coke and coke for heating purposes. When elevated flue temperatures are used, oven throughput is up to one quarter higher, the lump size of the coke and its mechanical strength diminish, and its abrasion is improved. Temperatures in the flues and the regenerators are so high that permanent use of this method necessitates replacing at least the top of the regenerator filling by silica bricks.

DESULFURIZATION AND PURIFICATION

7811 (FE—2033-19(Vol.1)) **Hot low Btu producer gas desulfurization in fixed bed of iron oxide-fly ash. Final report, 1 July 1975—30 April 1977. Volume I.** Joshi, D.K.; Leuenberger, E.L. (Air Products and Chemicals, Inc., Marcus Hook, Pa. (USA)). Sep 1977. Contract EX-76-C-01-2033. 208p. Dep. NTIS, PC A10/MF A01.

This work was undertaken to support the Morgantown Energy Research Center on their development of a process for desulfurizing hot, low BTU producer gas with iron oxide sorbents. Specific objectives were sorbent development and definition of scale-up criteria for commercial design. Several experimental sorbents were prepared using commercially available raw materials and were tested for capacity for hydrogen sulfide removal from the producer gas. Effects of iron oxide source, iron oxide content, sorbent support and binder on sorbent performance were investigated. Changes in properties like porosity, crushing strength, surface area, attrition resistance, x-ray diffraction patterns, DTA, density of the sorbents after undergoing a single absorption and regeneration cycle were evaluated. Effects of process variables like GHSV, superficial velocity, temperature, H_2S concentration in producer gas, pellet diameter, iron oxide content and pressure on the absorption dynamics were experimentally determined. Several mathematical models to describe the isothermal sorption of H_2S were developed. All the models were evaluated using experimental data. The semi-empirical model was able to predict the shapes of breakthrough curves and sorbent performance at 10% breakthrough for H_2S. Several schemes were considered to regenerate sulfided sorbents and yield a high concentration of sulfur dioxide without exceeding 1500°F. A short experimental program was completed to study effects of process variables on regeneration dynamics using air-stream. Heat effects for the highly exothermic regeneration were incorporated in the isothermal sorption models and were tested with experimental data. The adiabatic kinetically controlled model was best able to correlate the regeneration data.

7812 Chemical cleaning of coal. Friedman, S.; Warzinski, R.P. (US ERDA, Pittsburgh, Pa). *J. Eng. Power;* **99**: No. 3, 361-364(Jul 1977).

Between the expensive coal conversion processes and the relatively inexpensive flotation and magnetic methods for pyrite removal are the chemical methods for desulfurizing coal. Chemical cleaning removes more sulfur than physical separations, less than coal conversion, at costs and investment which are intermediate. Fuel value losses are small for chemical methods, comparable with the best of the physical separation procedures. In addition, certain chemical treatment methods effect useful changes in coal composition and properties. The principal chemical desulfurization methods involve treatment, at elevated temperature, with either basic media or oxidizing systems. Aqueous sodium hydroxide, at 225°C, removes almost all of the pyrite from coal, while subsequent washing with dilute acid removes most of the remaining mineral matter. At 300°C, similar treatment can remove, in addition, up to 40 percent of the organic sulfur from coals and also destroy caking properties. Oxidative desulfurization, using steam and air, also removes most of the pyritic sulfur and 20-40 percent of the organic sulfur, under milder conditions than those required for alkali treatment. The steam-air desulfurization process is presently the simplest and cheapest concept for removing organic sulfur from coal, making much eastern and midwestern coal environmentally acceptable as boiler fuel at realistic cost.

HYDROGENATION

REFER ALSO TO CITATION(S) 7852

GASIFICATION

REFER ALSO TO CITATION(S) 7811, 7841, 7858, 7889, 7911, 8428, 8598

7813 (EPRI-AF—531) **Evaluation of intermediate-Btu coal gasification systems for retrofitting power plants. Final report.** Waitzman, D.A.; Faucett, H.L.; Nichols, D.E.; Tomlinson, S.V.; Broadfoot, W.J. (Tennessee Valley Authority, Muscle Shoals, Ala. (USA)). Aug 1977. 126p. Dep. NTIS, PC A07/MF A01.

Process and economic evaluations have been made of two different intermediate-Btu coal gasification systems retrofitted to an existing electric power unit. One of the systems uses fixed-bed, oxygen-blown Lurgi gasifiers for sized coal (coal fines are sold as a byproduct) with a tar and oil cleanup, hydrogen sulfide removal and sulfur recovery processes. The other system uses entrained-bed Koppers-Totzek gasifiers, which gasify the coal including fines, with a hydrogen sulfide removal and sulfur recovery process. Using a prescribed set of representative power unit, process design and economic premises, a base case (500 MW, 3.5% S in coal, existing unit) incorporating the latest available technology was defined for each system, including a complete material balance, equipment list, and construction and operating requirements. Capital investment, annual revenue requirements (7,000 hr/yr) and lifetime revenue requirements (over a 25-yr declining operating profile) were estimated for the base case of each system. A 3-yr construction schedule ending in mid-1976 was assumed for a midwestern location. Investment costs (mid-1975 dollars) can be scaled or altered to reflect any predictable project schedule, escalation rate, or location. The investment and revenue requirements for these intermediate-Btu gasification systems are compared with the investment and revenue requirements for six fixed-bed, low-Btu gasification systems which were evaluated in a previous study.

7814 (FE—2006-6) **Applied research and evaluation of process concepts for liquefaction and gasification of western coals. Quarterly progress report, October—December 1976.** Wiser, W.H. (Utah Univ., Salt Lake City (USA). Dept. of Mining, Metallurgical and Fuels Engineering). May 1977. Contract EX-76-C-01-2006. 92p. Dep. NTIS, PC A05/MF A01.

Research highlights from a few of the projects are summarized: Hydrogen transfer is low but reaction kinetics are rapid in the early stages of the dissolution of coal in hydrogen donor solvents. At longer times the kinetics of the conversion process are slower but hydrogen transfer is faster. Current results indicate that, although adsorption uptake of multiring aromatic compounds by activated aluminas at room temperature is concentration dependent, adsorption is essentially irreversible. Ramifications of this phenomenon for diffusion studies are being assessed. Coal residence time in a coiled-tube, entrained-flow hydrogenation reactor increases as the reactivity of the coal particles increases. Hydrogen and $ZnCl_2$ catalyst both increase reactivity and hence residence time. Components in the 80

to 100°C boiling range of a coal hydrogenation product have been identified by distillation and gas chromatography. Identified components represent 68 percent of the total fraction.

7815 (FE—2200-21) **Evaluation of the B and W slag-bath gasifier. Task report for task assignment F'' '6)-2.** Lamb, R.H. (Iowa State Water Resources Research Inst., Am (USA)). 19 Apr 1977. Contract EX-76-C-01-2200. 29p. Dep. NTIS, PC A03/MF A01.

The report includes conceptual designs for the B and W gasifier including material and energy balances, a process flowsheet, equipment sizes and capital cost estimates. An optimum usse for it would be in a Parsons oil-gas type plant. It has, therefore, been evaluated by comparing it as a substitute for the Parsons gasifier. The conclusions reached are that the process may be technically feasible but would not be competitive with some other processes with respect to economy and energy conservation. In view of the lack of advantages offered by the process and the lower energy conversion efficiency, no further work on the process is recommended.

7816 (FE—2218-10) **Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Monthly letter progress report, April—May 1977.** Anderson, E.M. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Materials and Chemical Technology Lab.). Jul 1977. Contract EX-76-C-01-2218. 11p. Dep. NTIS, PC A02/MF A01.

During the months of April and May work continued on Tasks II, III, V, VIA and B and VII and on the writing of the third quarterly report. Of these activities, the most effort was directed towards the reduction of the bonded strain gage data generated on Task VIA, instrumenting the vessel and setting up the strain gage, temperature and acoustic emission data acquisition systems, evaluating the heaters, and acquiring an acoustic emission signature on the vessel. This also included completing the design, construction, and installation of the pouring and tear out systems. The refractories to be used for the first three runs were also ordered and received during this period. The preliminary math model was completed and used to predict the strain in the first liner test. Some delivery and equipment related problems were experienced during this two-month period that have put the test run phase of the program approximately two months behind schedule. The heater elements and casting forms and modified muller mixers were not received until April and had to be repaired and/or modified before they were ready for use. Due to this situation, the first lining was installed during May but the first heat-up test was not scheduled until early June. It is hoped that this schedule can be accelerated with the use of the two center vessel sections or possibly by combining two tests in one. The potential of these solutions will be better appreciated after the first few liner tests and tear outs are performed. The progress and accomplishments of each task are briefly described.

7817 (FE—2218-12) **Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Bimonthly letter progress report, July—August 1977.** Anderson, E.M. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Materials and Chemical Technology Lab.). Sep 1977. Contract EX-76-C-01-2218. 9p. Dep. NTIS, PC A02/MF A01.

During July and August work continued on Tasks II, III, V, VIB, and VII and was begun on Task VIII. The third quarterly report was completed and the annual report was begun. The following significant progress was made: Lining No. 2 (dual component configuration with coated anchors) was installed and tested to 1200°F using the modified Case No. 1 heat-up schedule. The lining was cracked after the test. The temperature, strain and AE data from linings No. 1 and 2 were reduced and initially analyzed. The analyses indicate that additional material property determinations, an anchorless lining test run and information from the tear-out of lining No. 2 are needed to fully understand the results. The lining and vessel shell strain and stress predictions for linings No. 1 and 2 were essentially the same for the two linings since they did not include refractory/anchor interactions. The effects of different types of shrinkage (time vs. temperature dependent) were included in these predictions. Two review meetings were held at the Lynchburg Research Center with ERDA technical personnel and ERDA contractors. One was a program review with the technical contract monitor. The other was with personnel from BCL, MIT and ERDA to discuss heat transfer and assist the MIT personnel in starting their program on the modeling of anchor/refractory interactions. Creep testing of the 90+% Al_2O_3 phosphate bonded ramming mixes indicate that they have excellent creep resistance up to approximately 1800°F but then creep significantly at and above this temperature. Up to four workable modified Ailtech strain gages capable of up to 1800°F have been made through the BCL subcontract. A reassessment of the program work scope was started to develop a revised schedule for the remainder of the program. This revised schedule will be reviewed with the contract monitor in September. The activities and progress of each task are briefly described.

7818 (FE—2247-7) **Gasification of residual materials from coal liquefaction. Annual report, July 1976—June 1977.** Robin, A.M. (Texaco, Inc., Montebello, Calif. (USA). Montebello Research Lab.). Jul 1977. Contract EX-76-C-01-2247. 23p. Dep. NTIS, PC A02/MF A01.

Type I (laboratory) evaluations have been completed on five samples of residues from four coal liquefaction processes. Four of the five samples were judged to be suitable feedstocks for the Texaco Coal Gasification Process. These materials are listed in Table I. A Type II (preliminary pilot plant) evaluation of 20 bbls of Syncrude Vacuum Tower Bottoms from the H-Coal liquefaction of Illinois No. 6 coal was successfully completed. The data indicate that a high conversion of carbon to syngas was achieved with predicted oxygen consumption.

7819 (FE—2299-13) **Sulfidation-resistant alloy for coal gasification service. Monthly report, 1 June—30 June 1977.** Perkins, R.A.; Bhat, M.S. (California Univ., Berkeley (USA); Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). 10 Jul 1977. Contract EX-76-C-01-2299. 5p. Dep. NTIS, PC A02/MF A01.

The effects of H_2S on Fe—Cr—Al—Y alloys were studied at 1800°F and 1000 psi. The sample was totally destroyed by sulfidation in less than 1000 hr. At 1 atm the alloy had good resistance to H_2S. Additional tests are being conducted to determine the effects of additions of small amounts of various metals on corrosion resistance.

7820 (FE—2299-14) **Sulfidation-resistant alloy for coal gasification service. Monthly report, 1 July—31 July 1977.** Perkins, R.A.; Bhat, M.S. (California Univ., Berkeley (USA); Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.). 10 Aug 1977. Contract EX-76-C-01-2299. 18p. Dep. NTIS, PC A02/MF A01.

The effects of H_2S on Fe—Cr—Al—Hf and Fe—Cr—Si alloys were studied at 1800°F for 1061 hr. All alloys developed protective oxide scales and exhibited good resistance to sulfidation. Internal sulfidation was detected in the Fe—Cr—Al—Y alloy studied previously. The study of surface conditions is continuing, and the effects of cold work, annealing, and pre-oxidation treatments on Fe—Cr—Al and Fe—Cr—Si alloys will be evaluated.

7821 (FE—2317-1) **Thermal effects during material conversion and catalytic processes. Quarterly report, April—June 1976.** Low, M.J.D. (New York Univ., N.Y. (USA). Dept. of Chemistry). Oct 1976. Contract EX-76-S-01-2317. 4p. Dep. NTIS, PC A02/MF A01.

The project is concerned with making radiometric measurements of the temperature of catalyst surfaces under varying conditions. The project is in the "starting-up" phase, and the work has been mainly concerned with the construction of measuring systems.

7822 (FE—2336-14) **Modification and operation of the atmospheric ash-agglomerating gasifier on coal. Project 9020 monthly progress report, July 1977.** Sandstrom, W.A. (Institute of Gas Technology, Chicago, Ill. (USA)). Sep 1977. Contract EX-76-C-01-2336. 26p. Dep. NTIS, PC A03/MF A01.

During the second month of Task 2 operation, coal was fed and gasified in the AAG reactor. The first coal test, Run 105, was conducted in the steam-oxygen mode and produced a 222 Btu/CF gas at approximately 1500°F. No ash agglomerates were produced for it was difficult to sustain steady-state operation because controllability of the L-valve feeder was undependable. Though numerous feed interruptions did occur, no tars or condensables were evolved, as fuel gas was produced from the direct feeding of subbituminous coal to the AAG gasifier. All feeding was undertaken through the L-valve leading directly into the bed. Condensable free fuel gas production was verified by an examination of the downstream fines collectors and by analysis of the fines. Test work was suspended during the last half of July because of the annual IGT Pilot Plant facilities turnaround. During this period cold test work was conducted on the L-valve to achieve flow controllability. Success was limited, and an alternative system was prepared to feed directly to the bed using the reactor screw feeder for the next test.

7823 (FE—2340-3) **Improved techniques for gasifying coal. Third quarterly report, January 1—March 31, 1977.** Graff, R.A.; Yerushalmi, J. (City Coll., New York (USA)). Sep 1977. Contract EX-76-S-01-2340. 32p. Dep. NTIS, PC A03/MF A01.

Fluidization experiments conducted with power station fly ash in the 6-inch system provided a dramatic demonstration that cohesive solids which could hardly be fluidized in the low-velocity bubbling regime could be maintained in vigorous fluidization in high-velocity beds. Experiments were conducted to study the various fluidization regimes and the transitions between them. The transitions from slugging to the turbulent state observed with Dicalite 4200 and a new solid, HFZ-20, were not as sharp as that observed with FCC. Additional experiments with FCC lend further confirmation to the possibility that a turbulent fluidization regime, distinct from the fast bed state, exists and bridges bubbling and fast fluidization. Gas backmixing was appreciable in the bubbling regime; it is

considerably less, though not insignificant, in the turbulent regime, and the gas is essentially in plug flow in the fast fluidized bed. Experiments carried out to measure the pressure drop across the primary cyclone and its capture efficiency with FCC as the test solid confirmed that at high solid rates the capture efficiency increases with decreasing gas velocity at the entrance to the cyclone. Experiments in flash hydrogenation and flash hydrolysis are described.

7824 (FE—2368-2) **Study of coal reactivities. Quarterly report, September 1—November 30, 1976.** Angus, J.C.; Gardner, N.C.; Leto, J.J.; Shine, S.M.; Williams, R.J. (Case Western Reserve Univ., Cleveland, Ohio (USA). Dept. of Chemical Engineering). Dec 1976. Contract EX-76-S-01-2368. 12p. Dep. NTIS, PC A03/MF A01.

There were three major efforts undertaken during the second quarter of the contract. The design of the second generation thermobalance (Task 1) was essentially completed and orders placed for the critical components, including the balance and the reactor core. The gasification rate data will be taken by weighing the entire reactor, rather than weighing a hanging basket within the reactor core. This procedure will permit the use of larger sample sizes, give greater accuracy of mass measurements and product gas composition, and will provide a more reliable, trouble-free instrument. A preliminary prototype of a gas transport coal feeder has been constructed and appears to work satisfactorily. Blowing the powdered coal into the hot reactor zone will permit better duplication of process conditions, will provide faster heat up rates, and will allow the study of the early stages of gasification. A critical analysis of the data taken during the first quarter was undertaken. This is part of Task 3. An attempt was made to understand the apparent decrease in primary methane yield with decreasing temperature. It is suspected that this effect may be all, or in part, caused by steam reforming reactions in the sample lines subsequent to the gasification step. Experiments are being set up to test this hypothesis. An ultra high vacuum system was modified for use on the present contract. This instrument will be used to make BET surface area measurements on coal and char samples. This work is part of Task 4.

7825 (FE—2433-14) **Environmental assessment of the HYGAS Process. Monthly progress report, May 1—May 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Sep 1977. Contract EX-76-C-01-2433. 21p. Dep. NTIS, PC A02/MF A01.

The environmental assessment program for the HYGAS Process was started with HYGAS Tests 55 through 58, which utilized Montana subbituminous coal (nonagglomerating) from the Rosebud seam. Beginning with HYGAS Test 59, pilot plant studies were started with Illinois No. 6 bituminous coal from the Peabody No. 10 Mine. In the HYGAS tests with subbituminous coals, light-oil samples recovered from the steam stripper were analyzed for organic constituents by gas chromatography-mass spectrometer (GCMS) techniques. Phenols were not detected in the stripped oil samples; consequently, samples of the coal feed oil slurry were recovered and analyzed primarily for phenols. These samples showed detectable and significant levels of phenols (0.8 to 3.8 wt. percent). Compared with the stripped oil, these samples also showed higher levels for 2- and 3-ring compounds and detectable levels of additional 4- and 5-ring compounds. The phenols were characterized and compared with phenols found in Test 37 with lignite coal, which showed major fractions of C_1- and C_2-phenols (approximately 40 percent each) with minor fractions of phenol and C_3-phenols. For subbituminous coals, the major fractions consisted of C_1-, C_2-, and C_3-phenols (approximately 30 percent each); minor fractions of phenol and C_4-phenol (approximately 10 percent each); and approximately 1 percent C_5-phenol. Support studies continue with simulated process gas mixtures to determine catalytic contaminant alterations that occur during water-gas shift reactions. The catalyst being studied is sulfur-active BASF K8-11. In recent tests, the feed gas contained low-level concentrations of NH_3, COS, and low molecular weight unsaturated alkenes. Test 4 is reported with about 75 percent COS conversion to H_2S and 66 percent hydrogenation of butene to butane.

7826 (FE—2434-17) **Pipline gas from coal-hydrogenation (IGT Hydrogasification Process). Project 9000 monthly status report, July 1—July 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Sep 1977. Contract EX-76-C-01-2434. 26p. Dep. NTIS, PC A03/MF A01.

The objective of this project is to perform the necessary pilot plant operations and related support studies required to acquire data for a commercial demonstration plant design based on the HYGAS Process. To this end, the annual plant turnaround was conducted during July. This turnaround period is required for routine maintenance, repairs, and installation of new equipment. The design and construction of a cold-flow model to simulate the second-stage gasifier and steam-oxygen gasifier were initiated. This model will be used to investigate how the fluidized bed is established in the steam-oxygen gasifier and the stability of the bed to process upsets. As such, it will aid in providing demonstration plant design information. Early in July a post-run inspection and cleanup were conducted after Test 63. Details are reported together with preliminary results of Test 63. The rest of July was spent on the annual plant turnaround. All sections of the plant were inspected, and a variety of equipment was replaced, repaired, or installed. A cold-flow model simulating the second-stage gasifier and the steam-oxygen gasifier is being fabricated and installed. A detailed comparison of the actual HYGAS reactor results vs. those predicted by a computer model simulation is presented.

7827 (FE—2518-6) **Hydrogasifier development for the Hydrane process. Monthly progress report, July 1977.** Gray, J.A.; Greene, M.I. (Cities Service Research and Development Co., Cranbury, N.J. (USA)). Aug 1977. Contract EF-77-C-01-2518. 27p. Dep. NTIS, PC A03/MF A01.

Cities Service completed nine tests during July using both a vertical and helical entrained-flow reactor. Fourteen tests have been run to date at hydrogen pressures of 500 to 1500 psig, temperatures of 1500 to 1719°F, and residence times of 295 to 1521 msec. Total carbon conversions vary between 18.6 and 42.1 percent and agree within the data scatter with previous Cities Service lignite data. Product yields for the Montana Rosebud coal were nearly the same as those with lignite. Fabrication of the 1/4-ton/hr reactor tubes, preburner, injector, electrical preheater, reactor pressure shell, and quench section is complete and all hardware has been delivered to the test site for assembly. The modification of the 1/4-ton/hr test facility is essentially complete with minor work remaining on the condenser tie-in to the reactor system and the hand-rails and stairs on the reactor work platform. Pulverized Montana Rosebud coal is being dried in preparation for the first test, estimated to occur near 15 August. Programming of the homogeneous gas phase reaction portion of the Rocketdyne reactor model has been completed and successfully checked out.

7828 (FE—2518-9) **Hydrogasifier development for the Hydrane process. Monthly progress report, September 1977.** Combs, L.P.; Greene, M.I. (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). Oct 1977. Contract EF-77-C-01-2518. 26p. Dep. NTIS, PC A03/MF A01.

Work during September was largely devoted to installation and checkout of a modular product recovery system. Once completed, the revised system was used in three tests of Rosebud subbituminous coal at nominal reactor conditions of 1600 psig, 3500 milliseconds residence time and 1475 to 1625°F. This brings to 26 the total number of tests run to date at hydrogen pressures of 500 to 1600 psig, temperatures of 1475 to 1728°F and residence times of 295 to 3500 msec. For the test results available to date, coal conversions have varied from 27 to 58 wt percent MAF and carbon conversions from 19 to 45 wt percent with hydrocarbon gas selectivity of 43 to 65 percent, hydrocarbon liquids selectivity of 12 to 32 percent and carbon oxides selectivity of 13 to 34 percent, respectively. Six tests of the 1/4-ton/hr reactor system were conducted during September, bringing the total number of tests run to date to eight. Preliminary analysis of analytical chemical data obtained to date indicates that overall conversions and conversions to gaseous products were in substantial agreement with the Cities Service bench-scale results.

7829 (FE—2565-1) **Analysis of coal hydrogasification processes. Quarterly technical progress report, February 1—May 31, 1977.** (Bechtel Corp., San Francisco, Calif. (USA)). Jun 1977. Contract EF-77-A-01-2565. 36p. Dep. NTIS, PC A03/MF A01.

Work associated with the first two tasks (Task I and Task II) of a program to investigate the operability and scaleup feasibility of three coal hydrogasification processes: the Cities Service process, the Rocketdyne process, and the ERDA Pittsburgh Energy Research Center (PERC) process is described. The report also contains a revised project schedule and revised organization chart. Task I is to conduct a survey of information in the public domain concerning the three hydrogasification processes and to supplement this survey with visits for discussion, expansion, and updating. During the reporting period, contact was made with the personnel at Cities Service, Rocketdyne, and PERC: the required hydrogasification data were requested; progress reports and technical papers dating back to 1965 were received from PERC; and a literature review was conducted on coal hydrogasification processes, dating back to 1964. Task II is to perform a detailed analysis of the hydrogasification data from the three processes, as required to evaluate the information for a pilot plant application. A tabulation was made of a portion of the data received from PERC for the free-fall dilute-phase (FDP) reactor. Conclusions drawn from the data are: (1) for a high-volatile A bituminous coal, carbon conversion efficiency is a function of H_2 partial pressure and is relatively independent of reactor temperature between 850 and 900°C; and (2) for a high-volatile C bituminous coal, carbon conversion efficiency is a function of reactor temperature and is relatively independent of H_2 partial pressure at 900°C.

7830 (FE—2565-3) **Analysis of coal hydrogasification processes. Monthly technical progress report, July 1—31, 1977.** (Bechtel Corp., San Francisco, Calif. (USA)). Aug 1977. Contract EF-77-A-01-2565. 43p. Dep. NTIS, PC A03/MF A01.

This program is being performed in four sequential tasks: Task I—Data Collection; Task II—Data Analysis; Task III—Process

Modeling; and Task IV—Identification of Additional Data and Recommended Experimental Programs. During July, substantial progress was made on Tasks II and III. Hydrogasification and partial liquefaction data received from Rocketdyne, Cities Service, and ERDA Pittsburgh Energy Research Center (PERC) were entered into a computerized data base, and semiempirical correlations for predicting carbon conversion efficiency and carbon selectivity to gas were fitted to the data. An analysis of process design, control methods, and other matters pertaining to engineering judgment that affect PDU and commercial-scale plant operability and/or feasibility is continuing. In mid-July, a meeting was held in Washington, D.C. between personnel from ERDA and Bechtel to review the status of the program.

7831 (IPC—76-42) **Coal derived petrochemicals.** White, P.C. (Energy Research and Development Administration, Washington, D.C. (USA)). 1976. 10p. (CONF-7604139—3). Petroleum Refiners Association, Washington, DC.

From 1. international petrochemical conference; San Antonio, Texas, USA (4 Apr 1976).

The basic technology for coal gasification, the separation of hydrogen from the syngas, and the synthesis of ammonia from that hydrogen, now exists and is practiced commercially in some parts of the world. In the terms of fossil energy technology, what is needed, therefore, is not a new breakthrough but simply evolutionary improvements that will reduce the cost of the gasification step and the separation of hydrogen from the syngas. Efforts currently underway to expand our overall effort of making hydrogen from coal are based on our needs for hydrogen for further upgrading of the conversion products to either syngas or syncrude, rather than for ammonia for fertilizer. We need to get a better fix than we have today in ERDA on the specific requirements for hydrogen for existing U.S. ammonia production, how this relates to the hydrogen requirements for syngas and synfuels and how it relates to the proposed expanded world needs for ammonia. We are going to have to greatly increase our production of nitrogen-based fertilizer to avoid serious agricultural problems. Since ammonia synthesis is an energy intensive process, we also need to look at the energy requirements of the process as well as its hydrogen needs. We should then relate these requirements to those we have already estimated for chemical feedstocks in toto and how these stand as a fraction of the quads of energy and hydrogen equivalent that are estimated to be coming from the present ERDA programs on coal, nuclear and solar power.

7832 (MERC/RI—77/3) **Test and evaluation of an aluminum oxide ball and seat in a ball valve.** Gardner, J.F. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). Oct 1977. 25p. Dep. NTIS, PC A02/MF A01.

Results of tests performed for the evaluation of a ceramic aluminum oxide ball and seat installed in a 6-inch WKM Class 300, full port ball valve are documented. The valve was MERC Valve Number 0612 obtained from the Morgantown Energy Research Center (MERC) 42-Inch Gas Producer. The valve body and ceramic parts are shown. The valve was subjected to 50 cycles of alternate pressure and operation. The ceramic ball experienced substantial chipping along the port edge and along the edge of the stem socket. After 50 operating cycles, the leakage increased by approximately 25%. Analysis of the damaged ball indicated the chipping was caused by stress concentration at the edges. The use of ceramic parts in ball valves requires careful design to avoid stress concentration. Duplication of a metal ball and seat design generally will not work. Additional care should be taken to assure an improved finish of the ball and seat surfaces over that evidenced in the sample tested.

7833 (PB—268106) **Metallurgical analysis of a plain carbon-steel plate after long-term service in a coal gasifier. Investigation report.** Fischer, J.R.; DeAngelis, R.J.; Gillis, P.P.; Hahn, O.J. (Kentucky Univ., Lexington (USA). Inst. for Mining and Minerals Research). Apr 1977. 58p. (IMMR—27-PD16-77). NTIS PC A04/MF A01.

A steel inner liner which was directly exposed to a coal gasification reaction for 20 years was examined. The microstructure was observed, the mechanical properties measured, and the chemical composition analyzed as functions of position in the vessel. Evidence of corrosion, embrittlement, and carburization was sought. Microstructural variations were rationalized and a correlation of microstructure and mechanical properties was attempted. The initial properties of the steel were estimated and compared to the final measured properties. Certain conclusions were reached concerning the operating conditions of the vessel and the suitability of the material for its design environment. Two materials samples from another high-pressure gasifier were obtained in 1974 when the inner lined failed while in service. Details are presented in the Appendix to this report.

7834 (PB—268576) **In-situ coal gasification: status of technology and environmental impact. Exhibit a report, Oct 1976—Feb 1977.** Phillips, N.P.; Muela, C.A. (Radian Corp., Austin, Tex. (USA)). May 1977. Contract EPA-68-02-2147. 184p. NTIS PC A09/MF A01.

The report gives results of a literature review and personal contacts to ascertain what is being done in in-situ coal gasification and to collect existing environmental data. It presents a general description of the chemistry, technology, and technological problems, along with detailed descriptions of the technical objectives, approaches, and results of ongoing projects. This presentation is used as a basis for summarizing the current state of knowledge regarding environmental issues.

7835 (UCRL—52283) **Historical development of underground coal gasification.** Olness, D.; Gregg, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1977. Contract W-7405-ENG-48. 58p. Dep. NTIS, PC A04/MF A01.

The development of underground coal gasification is traced through a discussion of the significant, early experiments with in situ gasification. Emphasized are the features of each experiment that were important in helping to alter and refine the process to its present state. Experimental details, coal characteristics, and gasification data are supplied for many of the experiments.

7836 **Pressure reaction cuts gasification costs.** Banchik, I.N. *Hydrocarbon Process.;* **56**: No. 3, 121-125(Mar 1977).

Results of an economic study of the Winkler process are reported. The economic optimum operating pressure is between 120 and 150 psia. Pressurization of the reactor decreases the number of gasification trains required for a given input. Increase in pressure beyond the optimum does not reduce the number of gasifiers, but reduces their size. However, gas price increases with higher pressure because the increased cost of the reactors outweighs savings. The article includes a description of the Winkler process.

7837 **Underground coal gasification.** Ledent, P. (Inst Natl des Ind Extr, Liege, Belg). *Ind. Miner. (St.-Etienne, Fr.) ;* **59**: No. 2, 81-91(Feb 1977). (In French).

Research efforts are now being made to find a new technique for underground in-situ coal gasification that would be applicable to relatively thin seams, situated at average or great depths. Two West European projects based on the use of high pressures are discussed. The Inieux (Liege-Belgium) project is destined to produce a low-quality gas to supply a power station with a combined gas-steam turbine cycle. The KFA (Juelich-West Germany) projects is aimed at providing substitute natural gas by hydrogasification. 13 refs.

7838 **Substitute natural gas from coal.** Aitken, E.J. *Min. Technol.;* **59**: No. 676, 57(Feb 1977).

Paper briefly describes two projects which have been completed at the Westfield Development Centre in Scotland: the gasification of certain American coals previously considered unsuitable for gasification, and the purification and methanation of lean gas from a Lurgi gasifier.

7839 **In situ coal gasification.** *Compressed Air;* **82**: No. 1, 14-15(Jan 1977).

The results of underground gasification tests at Hanna, Wyo, are reported. Among the instruments used to locate the region in which the reaction was occurring were thermocouples and passive acoustic sensors.

7840 **Coal gasification.** Hedden, K. (Univ., Karlsruhe, Ger.). pp 111-148 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Acacemic Press (1976).

Coal gasification is considered, with emphasis on the chemical reactions and thermodynamics involved. A number of gasification processes that are either commercial or in advanced stages of development are described with flowsheets. (LTN)

LIQUEFACTION

REFER ALSO TO CITATION(S) 7814, 7818, 7831, 7832, 7862, 7863, 7864, 7865, 7892, 7911, 7918, 8598

7841 (EPRI-AF—523) **Screening evaluation: synthetic liquid fuels manufacture. Final report.** Chow, T.K.; Stanbridge, D.W. (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Aug 1977. 129p. Dep. NTIS, PC A07/MF A01.

Various available and proposed gasification processes in combination with one methanol process in conceptual commercial size plant designs for production of clean liquid fuel from coal are compared. Additionally, a Fischer-Tropsch liquids plant design was included for direct comparison with a methanol case using one gasification process. The gasification processes screened in this study were entrained coal gasifiers representing commercial (Koppers-Totzek), near commercial (Texaco) and advanced concepts (Foster-Wheeler), as well as moving bed slagging gasifier (British Gas-Lurgi) now under development. The Chem Systems ebullating catalyst bed methanol process was used in combination with the above gasifiers. The British Gas-Lurgi gasifiers were used with the Fischer-Tropsch synthesis plant. The results indicate that there is an economic advantage to the advanced gasification systems for the production

of methanol. They also show that there is an economic advantage to the production of methanol over that of Fischer-Tropsch liquids when the same type of gasifier is used in both plants.

7842 (FE—1743-37) **Zinc halide hydrocracking process for distillate fuels from coal. Quarterly technical progress report, February 1—April 30, 1977.** Klunder, E.B.; Zielke, C.W.; Maskew, J.T.; Parker, W.A.; Pell, M.; Struck, R.T. (Conoco Coal Development Co., Library, Pa. (USA). Research Div.). 20 May 1977. Contract EX-76-C-01-1743. 30p. Dep. NTIS, PC A03/MF A01.

The bench-scale continuous hydrocracker has completed the original program of studies on Colstrip coal covering temperature, pressure, and residence time. A few additional runs will extend the matrix to more severe conditions. A reaction rate model will be developed. The gasoline produced in the above program meets specifications and has a research octane number of about 91. Complete balances on a continuous run confirm that 100 x 200°C distillate could be recycled as a coal vehicle with only 1 to 2% conversion to nongasoline per pass. Continuous tests of secondary recovery of zinc from the waste coal ash confirm that economic recovery of zinc chloride will be obtained. Construction of the 100 lb/hr Process Development Unit remains on schedule. Materials testing continues and is reported herein.

7843 (FE—1743-42) **Zinc halide hydrocracking process for distillate fuels from coal. Monthly technical progress report, August 1977.** (Conoco Coal Development Co., Library, Pa. (USA). Research Div.). 15 Sep 1977. Contract EX-76-C-01-1743. 13p. Dep. NTIS, PC A02/MF A01.

Three runs with material balances were made in the bench-scale hydrocracker. Material balance calculations were completed for three runs. Construction of the PDU continued with completion of the hydrocracking section scheduled for about December 1, 1977 and total plant completion by about February 21, 1978. Testing for obtaining a reliable manual valve for PDU use continued as well as corrosion coupon studies. Grinding and drying of several tons of Colstrip coal for PDU use was successfully demonstrated. Supporting work and progress on an economic study for secondary zinc recovery are described.

7844 (FE—2007-33) **Filtration process and equipment studies for coal liquefaction processes. Quarterly report, March—May 1977.** Smith, G.R.S.; Martin, P.C. (Johns-Manville Sales Corp., Denver, Colo. (USA)). 24 Jun 1977. Contract EX-76-C-01-2007. 27p. Dep. NTIS, PC A03/MF A01.

Filtration rates in excess of 700 pounds/hour/square foot were obtained at 100 psid differential pressure 600°F, 100 psid, 4 and 2 mil/cycle, 2 second immersions). Filtration rate dependence upon differential pressures up to 100 psid has been studied. Rates in excess of 450 pounds/hour/square foot (600°F, 100 psid, 5 second immersions, 4 mils/cycle) were obtained. A timing device has been installed on the test leaf allowing more accurate rate calculations, particularly for short immersion times. Rates obtained for two second immersions, simulating a 12 rpm drum speed, were above 650 pounds/hour/square foot (600°F, 70 psid, 4 mils/cycle blade advance). Filter aid usage under these conditions would be high, but can be lowered by reducing the knife advance rate.

7845 (FE—2211-6) **Chemistry of lignite liquefaction. Quarterly report, April—June 1977.** Stenberg, V.I.; Baltisberger, R.J.; Klabunde, K.J.; Woolsey, N.F.; Severson, D.; Souby, M. (North Dakota Univ., Grand Forks (USA)). Jul 1977. Contract EX-76-C-01-2211. 64p. Dep. NTIS, PC A04/MF A01.

Several samples of solvent-refined lignite and coal have been analyzed by various methods. Lignite samples have been hydrogenated to premium liquids using hydrogen and commercial catalysts. It was found that higher pressures and temperatures favored conversions although gas production also increased with increasing temperatures.

7846 (FE—2274-4) **Optimization studies of various coal-conversion systems. Quarterly report, January—March 1977.** Wen, C.Y. (West Virginia Univ., Morgantown (USA). Dept. of Chemical Engineering). Oct 1977. Contract EX-76-C-01-2274. 16p. Dep. NTIS, PC A02/MF A01.

One main objective of providing a model to simulate a coal liquefaction reactor is to maximize oil yield for a specific set of conditions. In investigating the dissolution rates of coal and hydrogen absorption into coal slurries, several correlations have been developed. Primarily, our findings show that solvent properties play a major role in the determination of the product's final properties. In this phase of the investigation various factors were investigated which affect the properties of the liquid product. The presence of asphaltenes appears to have a direct bearing on the viscosity of the final products as asphaltenes increase, so does the viscosity of liquid product. The viscosity continues this corresponding increase until a stage is reached which could promote hindrance of reactor operation. In addition, the ratios of oil/asphaltene in the feed and product were found to be related to each other.

7847 (FE—2321-17) **Catalyst development program for hydrodesulfurization and liquefaction of coal to produce clean boiler fuels. Monthly report, June 1977.** Hillenbrand, L.J.; Grotta, H.M.; Felton, G.W.; Harp, J.L.; Alcorn, W.R.; Elliott, G.E. (Battelle Columbus Labs., Ohio (USA)). Jul 1977. Contract EX-76-C-01-2321. 14p. Dep. NTIS, PC A02/MF A01.

During the thirteenth monthly reporting period work continued on construction and testing of the catalytic liquefaction reactor. Major tasks completed during this reporting period are listed.. Elimination of all major leakage, most of which resulted from many of the purchased components. These had to be either replaced or repaired. Piping modifications which enable the system to be pressurized to operating levels more quickly. Rework and addition of an additional air compressor to increase the available air supply. A two-day training class on gas chromatography was held for technicians who will operate the reactor. A familiarization operator training program was also conducted for the technicians who will operate the system. Calibration of several plant components was accomplished including the electronic weighing system, Foxboro gas flow instrumentation, and hydrogen gas alarm system. Completion of installation of all electrical heating cables, tapes, and temperature controllers. A first attempt to pump liquid through the system was unsuccessful. Catalyst preparation and screening work here continued. Eight runs were completed in June. Analytical data indicate that nickel-containing catalysts produce the highest oil/asphaltene ratios under standard test conditions while CoMo on alumina-silica produces rather poor results.

7848 (FE—2335-14) **Catalyst development coal liquefaction.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Edison, N.J. (USA). Engelhard Industries Div.). Aug 1977. Contract EF-76-C-01-2335. 10p. Dep. NTIS, PC A02/MF A01.

Various catalysts were formulated and prepared based on alumina and stabilized with La—Si or La—Zr. Additions were made of: Fe_2O_3 and MnO_2; SnO, CoO, and MoO_3; and SnO, CoO, TiO_2, and MoO_3. Studies were carried out on the role of surface acidity for coal liquefaction catalysts.

7849 (FE—2367-6) **Effects of solvent characteristics on Wyodak coal liquefaction. Quarterly technical progress report, May—July 1977.** Silver, H.F.; Hurtubise, R.J. (Wyoming Univ., Laramie (USA)). 15 Aug 1977. Contract EX-76-S-01-2367. 7p. Dep. NTIS, PC A02/MF A01.

During the fifth quarter of this project, efforts have been directed primarily toward producing and analyzing duplicate samples of liquefied Wyodak coal using Wyodak coal-derived recycle solvent from Wilsonville, Alabama, and hydrogenated products from this solvent. Solvent characterization procedures developed in previous phases of the program have been used to follow the effects of changes in the solvent used.

7850 (MERC—8007-1(Pt.1)) **Chemical properties of Synthoil products and feeds. Final report, Part 1.** Aczel, T.; Williams, R.B.; Pancirov, R.J.; Karchmer, J.H. (Exxon Research and Engineering Co., Baytown, Tex. (USA)). Sep 1976. Contract EY-76-C-21-8007. 239p. Dep. NTIS, PC A11/MF A01.

Nine liquid products from the Synthoil coal liquefaction process and extracts from three feed coals were analyzed for individual compounds, compound types, carbon numbers, and structural groups. Successive benzene and cyclohexane extractions produced oil, asphaltene, and residue fractions, and further clay-gel chromatography of the oil gave saturate, aromatic, and polar fractions that were examined extensively by a combination of other chromatographic and spectrometric methods. Mass spectrometry was used extensively on all fractions, but most of the individual compound identifications were on the aromatic fraction. Normal and iso-paraffins, and cycloparaffins were measured on the saturates (including isoprenoid paraffins and stearanes); aromatics, hydroaromatics, and neutral heterocyclics in the aromatic fractions; and phenolics, pyrrolics, and other heterocyclic aromatics in the polars. Up to 150 individual isomers, more than 300 compound types, and about 2500 separate carbon number homologs were determined in the oil fractions. Infrared measurements show that most of the oxygen is phenolic, but a considerably smaller fraction of the nitrogen is pyrrolic. Significant concentrations of carbonyl-containing groups are present only in the coal extracts. Besides IR and MS (on the volatile portion), other methods used to characterize the asphaltenes included NMR, GPC (for molecular weight distribution), elemental analyses, and UV-visible spectrometry. Asphaltenes are mostly large multi-ring aromatic structures, with heteroaromatic groups similar to those in the lower molecular weight polars. A number of relationships between product composition and processing conditions are evident.

7851 (MERC—8007-1(Pt.2)) **Chemical properties of Synthoil products and feeds. Final report, Part 2.** Aczel, T.; Williams, R.B.; Pancirov, R.J.; Karchmer, J.H. (Exxon Research and Engineering Co., Baytown, Tex. (USA)). Sep 1976. Contract EY-76-C-21-8007. 188p. Dep. NTIS, PC A09/MF A01.

Methods of sampling, fractionation and sample preparation are described for coal, coal liquids, coal extracts and asphaltenes in preparation for several kinds of instrumental analysis (gas chromatography, mass spectroscopy, infrared spectra, ultraviolet spectra, nuclear magnetic resonance, etc.). Analytical procedures, corrections, etc. are outlined. (LTN)

7852 Problem of obtaining liquid products from coal. Krichko, A.A.; Makar'ev, S.V. (Inst of Miner Fuels, USSR). *Ugol;* No. 2, 44-47(Feb 1977). (In Russian).

This state-of-the-art survey describes the research on the problem of coal liquefaction in a number of western countries and in the USSR. A new technology of coal hydrogenation developed in the USSR is briefly outlined. Use of petroleum products as an additive to the solvent helps to intensify the liquefaction process. In particular, utilization of the brown coal of the Kansk-Achinsk basin for coal liquefaction is envisaged. 11 refs.

7853 New South African plant for making liquid hydrocarbons from coal. Hoogendorn, J.C. *Gas Waerme Int.;* **25**: No. 6, 283-287(Jun 1976).

Sasol has for years been operating a plant in South Africa for producing liquid hydrocarbons from coal extracted from the country's rich coal deposits. The author describes the plant from its initial design concept up to its successful commercial operation. Owing to the situation in the world energy market it has now been decided to set up a further plant of this type which is scheduled to go on stream in 1979. The planned capacity and the design and layout of this plant are discussed.

PYROLYSIS AND CRACKING

7854 (EPRI-AF—528) Thermal and kinetic analysis of the pyrolysis of coals. Final report. Hathi, V.V.; Sliepcevich, C.M. (Oklahoma Univ., Norman (USA). Office of Research Administration). Aug 1977. 253p. Dep. NTIS, PC A12/MF A01.

The thermal decomposition (pyrolysis) of nine bituminous coals of the United States was investigated in a nitrogen atmosphere. Weight loss and rate of weight loss were measured at heating rates of 160, 80, 40, 20 and 10°C/min. The qualitative behavior of these data confirmed observations reported by others on similar coals in that the major devolatilization occurred between 300 and 700°C with the peaks shifting to higher temperatures at faster heating rates. Kinetic parameters for each heating rate were derived from these measurements by means of a model which has been used successfully to describe the pyrolysis of woods and wildland fuels. Energetic effects during pyrolysis were measured directly up to 727°C on a Perkin-Elmer differential scanning calorimeter (DSC-2) at heating rates of 320, 160 and 40°C/min. The decomposition of bituminous coals is endothermic up to 500°C and exothermic thereafter; the energy of pyrolysis is more exothermic with decreasing heating rates. However, quantitative repeatability of these energetic measurements was less than desired because of baseline shifts arising from condensation of decomposition products on the surfaces of the sample holder.

7855 Study of the pyrolysis of mixtures of Rhineland lignite and iron oxide by means of combined thermogravimetry-gas chromatography. Soudan-Moinet, C.; Tran, H.V. (Univ Libre de Bruxelles, Belg). *Ann. Mines Belg.;* No. 1, 73-83(Jan 1977). (In French).

To compare the reducing capacity of lignite and coal on iron oxides, thermogravimetric studies were made to determine the progress of pyrolysis in inert atmospheres, using mixtures of Rhineland lignite and iron oxides (magnetite and hematite) with an oxide content of 30% by weight. The heating regime selected exhibits a linear temperature gradient from ambient temperature to 1000°C, at a heating rate of 3.2°C per minute. The quantity of gas released is measured at the furnace outlet by the thermogravimetric method; the gases were analyzed by means of gas-phase chromatography. The results are compared with those obtained for a bituminous coal in similar conditions. 16 refs.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 7908

7856 (FE—2270-20) Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Monthly technical progress report for August 1977. Lewis, H.E.; Weber, W.H.; Usnick, G.B.; Hollenack, W.R.; Hooks, H.W. (Catalytic, Inc., Wilsonville, Ala. (USA)). Sep 1977. Contract EX-76-C-01-2270. 20p. Dep. NTIS, PC A02/MF A01.

The Wilsonville SRC pilot plant operated 511 hours, or was on-stream 69 percent of the time during August. The distillation section operated an additional 58 hr. All operational time was used to process Indiana V coal from the Old Ben No. 1 Mine. A material balance was in progress at the start of the month. This was completed on 1 August. To obtain short residence time data and product samples, the dissolver was bypassed starting 3 August. The bypass run was terminated because of mechanical problems on 4 August after samples were obtained. A period of operations to produce SRC with a lower sulfur content was completed on 21 August. The sulfur in the SRC was in the range of 0.7 percent. Both the Sharples and the Dorr-Oliver centrifuges were operated in series, with the Sharples underflow filtered in the Funda filter. Both machines operated satisfactorily for a period of 75 hr. The Sharples centrifuge reduced the solids content of the overflow to the expected level. Specification SRC was not obtained from the Dorr-Oliver centrifuge. It is believed that operation at about 525°F would improve the performance of the Dorr-Oliver machine. An examination of the upper part of the dissolver was made by Oak Ridge personnel. No evidence of cracking or corrosion was found.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 7852

7857 (PB—267998) Detection of phosphate adsorption onto coal humic acids. Isselhardt, L.O. (Missouri Univ., Columbia (USA). Dept. of Chemistry). Dec 1975. Contract DI-14-31-0001-4170. 113p. NTIS PC A06/MF A01.

Because of their acid-base, sorption, and chelation properties, coal humic acids have some potential applications in treating some of the pollutants arising from the mining, combustion, and conversion of coal and from stack gas scrubber effluents. This thesis is part of a research program designed to determine the interaction of coal humic acids with a variety of species found in wastewaters. The uptake of orthophosphates and polyphosphates by solid coal humic acids was examined. The preparation and purification of coal humic acids and iron humates are described. Details are given for the difficult analysis of phosphates in the presence of humic substances. It was found that coal humic acids adsorb phosphates very poorly. Since these materials effectively remove heavy metal ions from water the possibility is raised of selectively removing dangerous heavy metal ions while leaving nutrient phosphate in the water for fertilizer in water used for land reclamation or crop irrigation.

7858 Investigation of the design variables for producing activated carbons from Victorian brown coals by reaction with steam. McCarthy, D.J. (CSIRO, Clayton, Victoria, Aust). *Carbon;* **15**: No. 2, 95-101(1977).

Activation of Latrobe Valley brown coal by reaction with steam was investigated in a continuous indirectly heated shaft activator. The variables studied were the degree of coal gasification achieved, the ratio of steam feed rate to coal feed rate and temperature of activation. The most important of these variables is the degree of gasification of the coal. The ratio of steam feed rate to solids feed rate is unimportant when the value of this variable is greater than 0.036 g/g, and temperature is unimportant in the range 720-930°C. Process limitations which can be caused by channelling of both gas and solids and by heat transfer limitations have been discussed briefly. 14 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 7804, 7845, 7855, 7911, 7919, 8843

7859 (CONF-770963—1) Polycyclic aromatic hydrocarbons from fossil fuel conversion processes. Guerin, M.R.; Epler, J.L.; Griest, W.H.; Clark, B.R.; Rao, T.K. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From 2. international symposium on polynuclear aromatic hydrocarbons; Columbus, Ohio, USA (27 Sep 1977).

Benzo(a)pyrene continues to be the most widely accepted indicator of PAH content and biological significance. The concentrations of BaP in synfuels related materials are summarized. Petroleum crude is estimated to contain approximately 1 ppM of BaP. Both shale- and coal-derived crudes contain approximately three times as much BaP. Depending on the source (coal, process, process conditions), coal-derived crude oils contain BaP ranging from the same amount as petroleum crudes to ten times as much. High boiling distillates and distillate residues are generally enriched in BaP content as should be expected. While enriched in BaP relative to petroleum crudes, coal-derived crude oils contain two to three times less BaP than do coal tar, coal tar pitch, and petroleum pitch. Mutagenic activity is observed in the PAH fractions containing three-ring PAHs to those containing PAHs greater than five rings in size. The specific activity tends to "peak" for the 4-ring and 5-ring fractions, i.e., those containing the most common (benzo(a)pyrene, benzo(c)phenanthrene, 3-methylcholanthrene, etc.) known carcinogens. Of particular interest is the observation that fractions corre-

sponding to PAHs of 4-rings and larger contain constituents which do not require metabolic activation to express histidine reversion. It is also important to note that mutagenicity of the fraction is produced by at most 4-12 wt % (depending on whether enzyme activation is employed) of its constituents.

7860 (COO/4227—2) **Coal anion structure and chemistry of coal alkylation. Second quarterly progress report, June 1, 1977—August 31, 1977.** Stock, L.M. (Chicago Univ., Ill. (USA)). 1977. Contract EF-77-S-02-4227. 6p. Dep. NTIS, PC A02/MF A01.

Work is in progress concerning the proton and carbon nuclear magnetic resonance spectra of butylated coal samples obtained from E. Burk of the Atlantic Richfield Oil Corporation Research Laboratory in Harvey, Illinois. The synthesis of perdeuteriotetralin was completed. The control experiments using tetralin as a reagent for the conversion of Illinois 6 in tetralin have also been completed. Third, work on the reductive alkylation reaction of Illinois No. 6 coal samples continues.

7861 (LA-UR—77-1870) **New standard for electron microanalysis of organic sulfur in coal.** Raymond, R.; Gooley, R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. (CONF-770849—1). Dep. NTIS, PC A02/MF A01.

From Microprobe analytical society meeting; Boston, Massachusetts, USA (16 Aug 1977).

A standard for quantitative electron microprobe analysis of organic sulfur in coal has been prepared and tested. The standard consists of spherical carbon beads 75 to 200 μm in diameter that contain 4.1 +- 0.1 weight percent sulfur. The composition of the standard is very similar to coal and is therefore well suited for coal studies. Resulting data from use of the standard indicates: (1) a consistent relative order of various coal macerals with respect to organic sulfur content; (2) higher organic sulfur contents in high-sulfur coal than in low-sulfur coal; and (3) no organic sulfur gradient within coal macerals near sulfide grains. Analysis of organic sulfur content in macerals is suggested as a means for improved interpretation of molecular structures of coal.

7862 (MERC—8007-1(Pt.3)) **Chemical properties of Synthoil products and feeds. Final report, Part 3.** Aczel, T.; Williams, R.B.; Pancirov, R.J.; Karchmer, J.H. (Exxon Research and Engineering Co., Baytown, Tex. (USA)). Sep 1976. Contract EY-76-C-21-8007. 340p. Dep. NTIS, PC A15/MF A01.

Tables of the chemical composition of coal extracts and coal liquid products from the Synthoil process are presented based on chemical analysis or mass spectrometry of samples fractionated in various ways (extraction in various solvents, gas chromatography, etc.). (LTN)

7863 (MERC—8007-1(Pt.4)) **Chemical properties of Synthoil products and feeds. Final report, Part 4.** Aczel, T.; Williams, R.B.; Pancirov, R.J.; Karchmer, J.H. (Exxon Research and Engineering Co., Baytown, Tex. (USA)). Sep 1976. Contract EY-76-C-21-8007. 381p. Dep. NTIS, PC A17/MF A01.

Tables of the chemical composition of coal extracts and coal liquid products from the Synthoil process are presented based on chemical analysis or mass spectrometry of samples fractionated in various ways (extraction in various solvents, gas chromatography, etc.). (LTN)

7864 (MERC—8007-1(Pt.5)) **Chemical properties of Synthoil products and feeds. Final report, Part 5.** Aczel, T.; Williams, R.B.; Pancirov, R.J.; Karchmer, J.H. (Exxon Research and Engineering Co., Baytown, Tex. (USA)). Sep 1976. Contract EY-76-C-21-8007. 322p. Dep. NTIS, PC A14/MF A01.

Tables of the chemical composition of coal extracts and coal liquid products from the Synthoil process are presented based on chemical analysis or mass spectrometry of samples fractionated in various ways (extraction in various solvents, gas chromatography, etc.). (LTN)

7865 (MERC—8007-1(Summ.)) **Chemical properties of Synthoil products and feeds. Summary of final report.** Aczel, T.; Williams, R.B.; Pancirov, R.J.; Karchmer, J.H. (Exxon Research and Engineering Co., Baytown, Tex. (USA)). Feb 1977. Contract EY-76-C-21-8007. 44p. Dep. NTIS, PC A03/MF A01.

Data obtained on the Chemical Properties of Synthoil Products and Feeds are summarized. Emphasis is placed on the overall characterization, the individual compounds and carbon number homologs determined in the oil fractions, the structural parameters calculated for the asphaltene fractions and the possible correlations between product composition and processing conditions. The detailed data are published in a five volume final report entitled "Chemical Properties of Synthoil Products and Feeds." Synthoil feeds and products are extremely complex materials that can, however, be characterized in detail with the proper analytical methodology. The scope of the characterization can be gauged to the immediate or longer range process requirements. Significant correlations exist between product composition and processing conditions. The main effects of the process, apart from the increase in the oil fractions, include a drastic decrease in the sulfur content and a significant increase in hydroaromatic components.

7866 (PB—268086) **Chemical analyses of selected Missouri coals and some statistical implication.** Wedge, W.K.; Bhatia, D.M.S.; Rueff, A.W. (Missouri Dept. of Natural Resources, Rolla (USA). Div. of Geology and Land Survey). 1976. 42p. NTIS PC A03/MF A01.

The chemical composition of Missouri coals from active mining areas in northern and western Missouri has been investigated using X-ray fluorescence, optical emission, neutron activation, and wet chemical techniques including atomic absorption. Thirty complete, unweathered face channel samples were collected, representing 11 different coal beds of the Desmoinesian Series of the Pennsylvanian System of Missouri. Major and minor elements were determined. Ten major and minor elements and at least 20 trace elements in 20 coal samples representing 5 counties were grouped by geographic area and correlated using R-mode factor analysis. The mineral phases present in the coal and whether the elements show organic or inorganic affinity were inferred using this technique. The best statistical sorting was found in Henry County in western Missouri. Proximate (percent moisture, ash, volatile matter, and fixed carbon) and ultimate (percent carbon, oxygen, hydrogen, nitrogen, sulfur, and ash) analyses, Btu content, and forms of sulfur were also determined.

7867 (ERDA-tr—310) **Isolation and explanation of the structure of fractions rich in sulfur obtained from bituminous coal.** Gundermann, K.D.; Fiedler, G.; Wagner, M.; Debrodt, H.; Knoeppel, I. 1977. Translation of German report. 14p. Dep. NTIS, PC A02/MF A01.

Small percentages of organic compounds containing 3 to 4% sulfur were isolated from coal containing approximately 1% sulfur and tentatively identified by infrared spectra and mass spectrometry. Suggestions as to the synthesis of organic sulfur compounds in coal are made on the basis of the behavior of model compounds. It is concluded that some of the organic sulfur in coal is present in aliphatic or cycloaliphatic thio-ether groups. Various features of the chemical procedures involved are discussed. (LTN)

7868 **Developments in hard coal sampling and sample preparation.** Finze, W. *Aufbereit.-Tech.;* **17**: No. 12, 613-618(Dec 1976).

Problems of sampling and sample preparation are described with regard to the technical and economic development of hard coal processing. The fundamentals for obtaining analytical results of specific accuracy were determined by statistical procedures, and methods were laid down for verifying the accuracy of the analytical results obtained. The findings of these studies have been included in ISO standards. Advances in mining and preparation practice made it necessary to find new equipment for sampling and sample preparation.

7869 **Automatic sampler and sample splitter for coking coal.** Willman, E. *Aufbereit.-Tech.;* **17**: No. 12, 621-623(Dec 1976).

An automatic sampler and sample splitter is described. For sampling, a representative portion of the complete flow of material must be taken and reduced to the size of a laboratory sample.

7870 **Automated bulk sampling plays increasing role.** Jordison, F. *Coal, Gold Base Miner. South. Afr.;* **24**: No. 12, 63-68(Dec 1976).

Sampling equipment for bulk materials such as coal is described.

7871 **Forward gamma scatter for ash counts in r.o.m. coal belt flows.** Onishchenko, A.M. *Koks Khim.;* No. 11, 9-12(Nov 1976).

Americium-241 was used for simplicity, but was affected by size consist, bed thickness and moisture as well as porosity. Collimation of the beam was found to be essential and a gamma counter was placed above the belt precisely coaxial with the emitter. The main disturbing factor was bed thickness. Different detectors and beam configurations were investigated.

7872 **Factors affecting the bulk density of coal charges.** Kalach, N.I. *Koks Khim.;* No. 9, 9-10(Sep 1976).

The author employed mathematical analysis to find the correlation between changes in bulk density, size consist, moisture, and calorific value. The results are tabulated and suggest that it is the moisture in the first case, and secondly the joint effect of moisture and size consist which are responsible for changes in bulk density.

7873 **Study of the thermotechnical properties of Novokazansk coal from the Kuzbass field.** Novitskii, N.V.; Martynova, M.I. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 8, 85-89(Aug 1976).

Results are presented of tests on Novokazansk coal. Details are given of the petrographic composition, of some chemical constituents, of the ash content and ash properties, and of the moisture content. It is concluded that the coal is suitable for power generation.

7874 **Change in mechanical strength of preheated coals.** Morozov, O.S. *Koks Khim.;* No. 7, 6-8(Jul 1976).

A marked reduction in strength was found as moisture was reduced and temperature of preheat increased, though the effect was less for the high-ash fractions. It is suggested that the coal particles are crushed and broken in the early stages. Later, intramolecular changes are said to take place, reducing strength further.

7875 **Prediction of volatile matter in deep-level coals from Prokop'evsk—Kiselovsk.** Neskvov, V.M. *Koks Khim.;* No. 6, 1-2(Jun 1976).

The method proposed includes all the coal components and is based on the well-known additive property of the Volatile Matter index, namely that the yield in volatiles in any low-ash coal is governed by the total yield in volatiles of each single coal component. To find Volatile Matter yield for each group of micro-components, three samples of coal of different composition are used taken from a single place in any one seam. It is essential that the coals should be of low ash content; if it is greater than 10 percent the coals should be cleaned first. Each triad is then subjected to a quantitative petrographic analysis and in theory this should be carried out for each stage in the rank system in a particular deposit or coalfield. A graph is then produced to show the change in these Volatile Matter indices with increasing rank.

7876 **Soviet coal petrography, its theoretical bases and possibilities of using it to evaluate hard coals for the coking industry.** Kosina, M. *Sb. Pr. UVP;* No. 32, 179-207(1976).

Different approaches of Soviet coal petrologists to the problems of coal genesis and the possible use of micropetrographic methods for evaluating the technological properties of coal are discussed. Two theories of the origin of hard coals, the one-stage origin and the evolution theory developed by Ammosov, are considered. These different theories lead to diverse views of the potential of micropetrographic methods in practice, particularly for the evaluation of coking properties.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 7825

7877 (PB—267307) **Utilization of fly ash in polishing oxidation pond effluents. Project completion report, Jul 75-Jun 76.** Hung, Y. (North Dakota Water Resources Research Inst., Fargo (USA)). Aug 1976. Contract DI-14-34-0001-6035. 86p. (WI—221-037-76). NTIS PC A05/MF A01.

Sixteen fly ashes were investigated for their organic pollutant removal efficiency in the tertiary treatment of oxidation pond effluents in eastern North Dakota. The majority of fly ashes used were from the northcentral region including North Dakota, South Dakota, Montana and Saskatchewan. Both shaking runs (batch units) and filtration runs (continuous units) were employed. Mechanisms of organic removal by fly ashes were due to coagulation and adsorption by metallic oxides and also due to carbon adsorption. From batch tests it was found that increase in fly ash concentration resulted in an increase in TOC removal; sizes of fly ash and pretreatment of fly ashes employing washing of fly ashes did not have definite effect on the TOC removal for oxidation pond effluents. From continuous filtration tests it was shown that fly ash contained a high proportion of small particles which need to be removed before a reasonably high filtration rate can be attained. All filtration runs except the first run used those portions of fly ash with particle sizes larger than 0.0029 inches (U.S. sieve No. 200). Using a filtration rate of 0.0717 gpm/sq ft, which is commonly used in the slow sand filters, TOC removal by fly ashes was found to vary from 50 percent to 92.48 percent. Stratification of fly ash has effect on both the TOC removal and the filtration rate during the filtration study. The ungraded fly ash has the highest TOC removal but the lowest filtration rate, while the fine at top to coarse at bottom stratification has the lowest TOC removal but the highest filtration rate. It was also found that TOC removal decreases as filtration rate increases. Filtration process appears to be a better process than batch process for TOC removal of oxidation pond effluents.

7878 (PB—268525) **Sludge oxidation in limestone FGD scrubbers. Final report, Mar 1976—Jan 1977.** Borgwardt, R.H. (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Industrial Environmental Research Lab.). Jun 1977. 76p. (EPA—600/7-77/061). NTIS PC A05/MF A01.

The report gives results of an experimental study of techniques suitable for forcing the oxidation of calcium sulfite (a throwaway product of flue gas desulfurization scrubbers now operating in the U.S.) to gypsum, over a range of scrubber operating conditions applicable to the use of high-sulfur coals. Potential advantages of converting this product to gypsum include: (a) reduction of the total waste production, (b) improved settling and dewatering properties of the sludge, and (c) avoidance of chemical fixation of the sludge. It is shown that appropriate oxidizer designs can achieve complete conversion with reasonable air stoichiometries at atmospheric pressure without catalysts. Gypsum filterable to 80% solids can be obtained in either two- or single-stage scrubbers. In either case, efficiency is determined primarily by the physical absorption of oxygen from the air injected into the oxidizer, when the oxidation step is conducted within the scrubbing loop. The study shows that the required oxygen transfer efficiencies can be obtained either with an air-sparged tower or an air ejector, when used to aerate the slurry in the scrubber effluent hold tank. Merits of the various approaches are compared and discussed in terms of the quality of gypsum produced, operability of the system, air-feed pressure requirements, and predictability of performance when scaled-up to larger systems.

7879 (SAND—77-8707) **Particulate sizing in high-temperature, high-pressure combustion systems.** Coleman, H.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 27p. (CONF-770970—1). Dep. NTIS, PC A03/MF A01.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, District of Columbia, USA (20 Sep 1977).

The results of a review of particulate sizing techniques for application to turbine inlet flows in advanced, open-cycle gas turbine systems fired with pulverized coal, liquid and gaseous fuels derived from coal, and heavy residual fuels are discussed. Emphasis was on optical techniques, which provide nonperturbing, in-situ measurements. It was concluded that there are presently no commercially available instruments for reliable measurement of particulate sizes in high-temperature, high-pressure flows. For particulate size distribution measurement, the visibility, diffraction, intensity ratio and photography techniques were identified as the most promising for further development. Since some of the particulates in the combustor exit flow will be porous or hollow and agglomerates may contain voids, there is no reliable method for converting optically-determined number density and size distribution measurements into mass loading density values.

7880 **Weviton Steel Division: Brown's Island coke plant.** Tranbert, R.M. *Iron Steel Eng.;* **54**: No. 1, 61-64(Jan 1977).

Paper describes an 87-oven plant, which has been in operation since 1973, includes details of the biological oxidation system for effluent treatment. Phenol destruction in excess of 99% and TOC reduction in the 80 to 90% range are claimed.

7881 **Comparison of carbonate-based sorbents for sulfur dioxide in waste gases.** Hartman, M.; Pata, J. *Chem. Prum.;* **27**: No. 52, 230-234(1977). (In Russian).

Magnesium oxide formed by calcination of magnesite binds sulfur dioxide most rapidly at about 750°C. In the initial stages the reaction of sulfur dioxide with MgO is considerably slower than its reaction with CaO. With increasing conversion both reactions are strongly slowed down and differences in their respective rates level off. In comparison with magnesite and limestone, the extremely high reactivity of active sodium carbonate towards sulfur dioxide is remarkable. Sulfur dioxide binds to active soda at temperatures that are much lower (150 to 180°C) and with a reaction rate higher by one to two orders of magnitude than the rate corresponding to limestone. Moreover, while in the case of limestone the reaction practically stops before most of CaO in the sorbent particles has reacted, the particles of active soda remain reactive up to a very high degree of conversion.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 7825, 8566, 8996, 9021, 9028

7882 (ARP—33) **Inventory of unique uses for reclaimed strip mined land in the Appalachian region.** Rowe, J.E. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 1975. 39p. of Tennessee, Appalachian Resources Project, Knoxville.

This report pinpoints examples of various end products of the land reclamation process. It is intended to influence those responsible for reclamation into considering some of the unique uses mentioned. The spatial pattern of unique uses of reclaimed strip mined areas in the Appalachian Region suggests that developers and reclamation planners act on an individual basis and do not adhere to any regional plan. Development occurs near urban areas due to population pressures and the scarcity of easily developed land. Accessibility and demand determines the location and creation of unique developmental uses of reclaimed strip mined sites. Unaccessible strip mined areas are usually reclaimed to the minimum required by law.

7883 (ARP—34) **Regional economic impact of a ban on high slope coal surface mining.** Schlottmann, A.; Abrams, L.W. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). May 1975. 41p. of Tennessee, Appalachian Resources Project, Knoxville.

The primary result of the analysis is that a ban on high slope coal surface mining in 1978 would stimulate substantial increases in coal surface mining in the West. During the time framework of our analysis, little increase in coal mining in Appalachia could be stimulated. Also, the ban would increase the total sulfur content of steam coal by 4.5%. It is concluded that the ban would cause an ambiguous change in environmental quality at a cost of $309 million. Even though the ban improves environmental quality in Appalachia, it stimulates increased surface mining elsewhere, and thus, increases the environmental degradation in other regions. Increased surface mining in the West is an especially distressing result because of the alleged ineffectiveness of reclamation in arid regions where the soil is extremely fragile and water resources limited. Had the analysis indicated that the ban would stimulate substantial increases in underground mining, the conclusion would have been different. To be sure, coal extracted from underground mines does contribute to environmental degradation. However, coal extracted from underground mines would contribute much less to environmental degradation than coal extracted from surface mines. In our opinion, a ban on high slope surface mining represents another in a long line of environmental policies in which a new environmental problem is created in the process of solving some existing environmental problem. The "benefits" of the ban—a regional shift in environmental degradation caused by coal surface mining—do not appear to be greater than the costs of such policy.

7884 (ARP—46) **Social impact of surface mining in a rural Appalachian community.** Bryant, F.C. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 15 Jun 1976. 39p. of Tennessee, Appalachian Resources Project, Knoxville.

Since the initiation of surface mining in the watershed of Isaac's Creek, Anderson Co., Tenn., residents have experienced a variety of inconveniences, dangers, and property damages that many attribute to environmental alterations resulting from surface mining. Although these costs have been sustained by individual households, their impact has been greater than that which would be revealed by a summation of the problems suffered by individuals and families; for the magnitude and frequency of these damages have evoked responses that have promoted the alteration of the composition and social organization of the community. These responses and their cumulative community-level effects have been various. Many families have reacted to recurring damages and problems by electing to move away from the community, and these choices have resulted in a rapidly declining population size and possibly in a proportionally increasing number of unemployed individuals in the remaining population due to a selective out-migration of employed persons and their families. Those who have remained in the community, either through choice or because of the absence of viable alternatives, have increasingly purchased and sold land in accordance with market rather than social conditions, have discontinued many joint agricultural activities, and have drawn apart into fractions opposed over the issue of surface mining. These interrelated and mutually reinforcing trends have contributed to a dissolution or weakening of the many informal and overlapping social bonds that earlier characterized the social organization of Isaac's Creek and have detracted from the ability of the community to contribute to the welfare of its residents.

7885 (ARP—51) **Economic and environmental impacts of back-to-contour reclamation of surface coal mines in Central Appalachia.** Bohm, R.A. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 2 Mar 1977. 13p. of Tennessee, Appalachian Resources Project, Knoxville.

For United States Senate, Committee on Interior and Insular Affairs, Subcommittee on Minerals, Materials, and Fuels.

Back-to-contour reclamation is intended to represent a method for both protecting the environment and simultaneously recovering valuable and needed coal. To what extent, therefore, will back-to-contour reclamation succeed in reducing the environmental damages that have been shown to result from surface mining on steep slopes. These environmental damages represent the external costs of surface coal production that historically have not been reflected in the selling price of coal. These external costs are classified as tangible or intangible and as long-term or short-term. A tangible external cost is defined as one that is potentially measurable in real terms (i.e., dollars). The principal intangible external environmental cost of surface mining, both in the long and short term, is the aesthetic loss associated with an unreclaimed mine site. Back-to-contour reclamation is likely to be effective in reducing most long-term environmental impacts, but does not appear to be particularly effective in controlling short-term tangible damages of surface mining under steep-slope conditions (flooding, siltation, etc.). The findings suggest the need for careful study and monitoring of the degree of environmental protection afforded by back-to-contour reclamation. Also, the results imply that in cases where back-to-contour reclamation fails to adequately protect the environment that an alternative approach be permitted; or if no acceptable reclamation technique is available that mining be prohibited. Finally, the studies indicate the need for moving toward a formal procedure of compensating residents of coal-mining regions for damages incurred that cannot be prevented by reclamation.

7886 (CONF-770862—1) **Microbial ecology of coal mine refuse.** Cameron, R.E.; Miller, R.M. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 61p. Dep. NTIS, PC A04/MF A01.

From International symposium on microbial ecology; Dunedin, New Zealand (22 Aug 1977).

Baseline microbial and ecological studies of samples obtained from two abandoned coal mine refuse sites in the State of Illinois indicate that the unfavorable nature of refuse materials can be a very limiting factor for survival and growth of organisms. Despite the "foothold" obtained by some microorganisms, especially acidophilic fungi and some acidotolerant algae, the refuse materials should be amended or ameliorated to raise the pH, provide needed nutrients, especially nitrogen, and provide biodegradable organic matter, both for physical and biological purposes. Finally, the role of microbial populations, responses, and interactions in acid mine wastes must be put into larger perspective. Acid mine drainage amounts to over 4 million tons per year of acidity from active and abandoned mines. Microorganisms appear to be significantly responsible for this problem, but they also can play a beneficial and significant role in the amelioration or alieviation of this detrimental effect as abandoned mines are reclaimed and returned to useful productivity.

7887 (NP—22440) **Reclamation at Big Brown Steam Electric Station near Fairfield, Texas: geologic and hydrologic setting.** Henry, C.D.; Kaiser, W.R.; Groat, C.G. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1976. 12p. of Texas, Austin.

Texas lignite, in the areas now being mined, is moderately low in sulfur, and the topography is amenable to area stripping. The overburden material generally is suitable for the establishment of vegetation. These factors combine to make successful reclamation possible at the Big Brown site; similar reclamation programs have been imitated at the Monticello mine opened in 1974 and are planned for Martin Lake, scheduled to open in 1977. The reclamation and environmental programs maintained by Texas Utilities Generating Company started several years prior to the Texas Law regulating surface mining. The company had found it worthwhile to be thorough and innovative in its utilization of related property. Surface waters are kept on the property and monitored in holding ponds before being allowed to drain into area streams. With the lignite having an average sulfur content of approximately 1 percent and overburden that is low in sulfur, maintaining surface waters at a suitably high pH has not been a problem to date. However, some waters have shown high sulfate concentrations. Another problem that has been encountered is a drop in average pH in surface spoil in an agricultural test plot from an initial 6.6 to 5.3. This drop in pH may indicate a need for special handling of sulfurous materials during mining or special treatment of surface spoil such as liming to avoid future problems with mine drainage.

7888 (PB—267280) **Alluvial Valley floors in east-central Montana and their relation to strippable coal reserves: a reconnaissance report.** Schmidt, J. (Montana Energy Advisory Council, Helena (USA); Montana Dept. of Health and Environmental Sciences, Helena (USA)). Jan 1977. 148p. NTIS PC A07/MF A01.

This report is the result of reconnaissance field work and air photo interpretation conducted during late summer and fall, 1976. The chief purpose of the project was the preliminary assessment of the impact of a prohibition against mining alluvial valley floors on the coal resources of portions of Dawson, Garfield, McCone, and Richland Counties, Montana. A secondary purpose was the assessment of some of the physical and land use characteristics of these areas, and their importance to the local farming and ranching economy. Field work, data compilation, and report preparation were accomplished in less than five months. Thus, it must be emphasized that the report is reconnaissance in nature. The report is no substitute for site specific field work related to a particular mining proposal, which should document ground water levels, surface and subsurface soil and water salinity, aquifer relationships, the economic importance of a particular valley floor to individual ranchers and farmers, and identify specific mining and reclamation problems.

7889 (PB—267619) **Siting potential for coal gasification plants in the United States.** Lindquist, A.E. (Bureau of Mines, Denver, Colo. (USA). Intermountain Field Operation Center). 1977. 50p. (BM-IC—8735). NTIS PC A04/MF A01.

This report identifies areas of sufficient coal reserves to support synthetic natural gas development and summarizes those areas that have the highest potential. Capital requirements, mining and coal cost factors, water availability, and coal-quality data pertinent to synthetic natural gas production are presented. Evaluation of individual coal reserve blocks was based upon coal and water requirements of the Bureau of Mines Synthane coal-gasification process.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 7929

7890 (PB—267208) **Coal reserve study, New River Gorge, West Virginia. Open-file report.** Mory, P.C.; Brocoum, A.V.; Beers, A.H. (Bureau of Mines, Pittsburgh, Pa. (USA). Eastern Field Operation Center). Mar 1977. 39p. NTIS PC A03/MF A01.

The report is an appraisal of coal reserves in the New River Gorge area of West Virginia. It contains a description of the minable coalbeds in the area, an assessment of their reserves, and a study of the feasibility of mining from entries outside proposed boundaries of either a wild and scenic river area or a national park.

MINING

REFER ALSO TO CITATION(S) 7882, 7884, 7888, 7915, 7924, 8982

7891 (BM-IC—8757) **Comparative shortwall and room-and-pillar mining costs.** Green, L.E.; Palowitch, E.R. (Bureau of Mines, Washington, D.C. (USA)). 1977. 23p. Dep. NTIS, PC A02/MF A01.

For shortwall mining to be profitable, the additional capital investment of about $1 million for shortwall roof supports must be offset by decreased total operating costs and/or increased coal production. The Bureau of Mines therefore conducted a demonstration project to compare shortwall and room-and-pillar mining. Daily two-shift production from the Bureau of Mines-Beth-Elkhorn Corp. shortwall demonstration project averaged 975 tons of raw coal, compared with 905 tons from a room-and-pillar unit operating under similar conditions. The estimated direct operating costs for the shortwall and room-and-pillar units were $4.21 and $4.03 per ton, respectively. The profitability of the shortwall system was found to depend not only on the increased depreciation cost of the powered roof supports and the decreased cost of supplies and materials but also on such factors as the fixed and variable indirect costs and the selling price of the coal. Shortwall mining was demonstrated to be a viable alternative to room-and-pillar mining.

7892 (NP—22655) **Simulated solution mining of a Utah bituminous coal. Bulletin No. 144.** Roylance, T.F.; Anderson, L.L.; Pariseau, W.G.; Lattman, L.H. (Utah Engineering Experiment Station, Salt Lake City (USA)). Aug 1977. 74p. of Utah, Salt Lake City.

The overall concept of solution mining of coal was tested by a series of small scale experiments simulating field test conditions. These experiments were conducted in several areas including: In-situ coal liquefaction with external pressure on the coal sample varying from atmospheric to 1500 psi but no elevated temperatures (less than 350°C); in-situ coal liquefaction with external applied pressures, and utilizing elevated temperatures (greater than 350°C); in-situ coal liquefaction without external pressures but employing elevated temperatures (greater than 350°C); a study of the effects of using different solvents (liquefying vehicle); and a study of the time required to reach steady state extraction rate. Data were collected in the form of the extraction rate of coal samples maintaining temperature and pressure constant. The results pointed to the fact that heat was necessary for extraction of coal to occur. The coal extraction was also greater at atmospheric pressure than with higher static pressures applied to the sample. The end product produced by putting coal into solution was of significantly higher quality than the original coal. The ash content was reduced and the heating value was increased.

7893 (PB—267287) **Study of a water jet continuous coal mining system. Final report, Jun 75-May 76.** du Toit, P.J.G.; Sakhuja, A.; Black, S.; Graham, T. (Ingersoll-Rand Research, Inc., Princeton, N.J. (USA)). Mar 1977. Contract J0155138. 454p. NTIS PC A20/MF A01.

This report presents preliminary design and systems specifications of a demonstration miner (hydrominer), mining configurations showing good promise for typical U.S. thick coal seams in three seam pitch categories, and a definition of a test program that will provide sufficient engineering data for the design of a water jet cutting head adequate to cut coal in typical U.S. thick coal seams. The cost analysis data showed hydraulic methods to be economically competitive with present thick seam mining methods. It was also obvious from studies of thick seam methods that the hydromonitor coal breaking techniques are more effective in removing most of the coal with its long reach of 60 feet or more, is a safer mining system, and produces very low coal dust content in the air.

7894 (PB—267335) **Design of a machine familiarization trainer for Dragline operators. Phase I report. Appendices. Open file report.** Seidle, N.; McGill, D.; Purifoy, G. (Doron Precision Systems, Inc., Binghamton, N.Y. (USA)). Dec 1975. Contract H0155105. 160p. NTIS PC A08/MF A01.

Dragline operator tasks are analyzed. Dragline operator training objectives are described by task. Training objectives are related to performance requirements by task.

7895 (PB—267336) **Design of a machine familiarization trainer for dragline operators. Phase II report. Open file report.** Murphy, P.; McGill, D. (Doron Precision Systems, Inc., Binghamton, N.Y. (USA)). Nov 1976. Contract H0155105. 175p. NTIS PC A08/MF A01.

The report, and related appendices, provides a description of the functional design specifications, engineering design specifications, and program of instruction for development of a training system for dragline equipment operators. Based upon a task analysis and training system analysis prepared under phase I, phase II efforts expanded upon and refined the functional design specifications. The training hardware components have been developed to a point shy of system fabrication. A detailed outline of the program of instruction and content sequence has been prepared. The objective of the training system described in this report is to provide new operators of dragline equipment with the requisite skills and knowledge to assure cost-effective development and an adequate supply of our human resources.

7896 (PB—267337) **Design of a machine familiarization trainer for dragline operators. Phase II report. Appendix A: program of instruction-modules 10-17. appendix b: instructional time breakdowns. Open file report.** Murphy, P.; McGill, D. (Doron Precision Systems, Inc., Binghamton, N.Y. (USA)). Nov 1976. Contract H0155105. 587p. NTIS PC A25/MF A01.

A detailed outline of the program of instruction and content sequence is presented.

7897 **Principles of the introduction of statistical quality assessment of run-of-mine hard coal.** Martyniak, J. *Pr. Gl. Inst. Gorn., Komun.;* No. 670, 3-18(1976).

The author shows how continuous statistical quality assessment can be applied to run-of-mine coal. The quality indices considered were the refuse content in the over 30 mm size class, and the make of coal of size greater than 30 mm.

7898 **Principles of underground coal mine design:an approach. II.** Lama, R.D. (CSIRO, Aust). *Colliery Guardian;* **225**: No. 6, between p 333 and 344(Jun 1977).

Part 2 of this article on the fundamentals of underground coal mine design deals with several methods employed to define the factors affecting the production capacity and the size of mines, presents a cost analysis method, and then introduces a geomechanical approach to mine design. Geological and other factors influencing mine design are also considered.

7899 **Investigation of the dependence between density and pressure in a coal seam by a radioisotopic method.** Kimkov, V.I.; Vasil'ev, S.V. (Leningrad Min Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 1, 6-8(1977). (In Russian).

Mine investigations show that the efficacy of application of the density gamma-gamma method to study the state of stress of the rock body is determined above all by the character of the dependence between the density properties of rocks and the value of pressure on them. To advance from qualitative to quantitative measurements of loads acting in the rock body, an initial attempt is made to determine in detail the dependence of density on pressure in the rock body. The measurements are implemented by means of radiometric devices. Experiments in mines show a correspondence with laboratory test results.

7900 **Method to design coal mine variants.** Astashkin, N.V. (Donets State Univ, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 1, 43-48(1977). (In Russian).

A new approach to the formulation of coal mine plan variants is considered for the task of optimization of annual and long-term plans of Soviet coal production associations and of the coal industry as a whole. The main idea of the method is to work out each coal mine variant as an optimal complex of long wall variants and of the variant of development of the technological units of the mine as a whole under the assumption of set values of limiting resources. The design of a mine variant is implemented by solving a dynamic optimization problem in a stochastic formulation, locally for a mine, relying on a combination of the Monte Carlo methods and linear programming.

7901 **Drilling with down-the-hole hammers: use in coal mines.** Decherf, J. *Ind. Miner., Mine;* No. 1, 10-15(1977). (In French).

In the Nord et Pas-de-Calais coalfield, the mining of thin seams requires a large number of headings in stone or coal. This explains the great length of holes drilled in 1975--6,300 km by percussive drilling and 1,200 km by rotary drilling. Although the length drilled by down-the-hole (DHT) hammers is only 5 km, this technique is discussed here as it is of considerable interest for some specific types of mine work: Drilling of boreholes to test the dumped

coal waste, drilling through the floor for gas drainage, and drilling of large-diameter boreholes for tubing or advance holes.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 7908, 8575, 8897, 8898

7902 (NP—22636) **Computer simulation model for coal preparation plant design and control. Special research report Number SR-102.** Walters, A.D.; Ramani, R.V.; Stefanko, R. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 18 Feb 1976. 161p. State Univ., University Park.

In order to study the effect of various parameters on the efficiency of the operation, a computer model was developed to simulate a coal preparation operation consisting of blending of raw coal, screening and dense medium separation. To quantify the efficiency of the gravity separation, three criteria have been used, namely: Organic efficiency (effect of raw coal characteristics); probable error (effect of the cleaning unit); and economic efficiency (effect of the product selling price). To calculate the predicted yield from a dense medium separation, it is necessary to apply distribution factors from a distribution curve to the raw coal washability data. This presents problems from two aspects: The shape of the curve varies with the specific gravity of the separation; and the representation of the curve in computer form so that interpolation between known points is possible. The main application of the model was the optimization of the overall yield from two size fractions to produce a combined washed coal fraction of a given quality. Other applications are suggested.

7903 **Merry-go-round trains.** Rainbow, M. (CEGB, Engl). *Colliery Guardian;* **225**: No. 6, between p 319 and 329(Jun 1977).

The movement of coal from collieries to the power plants of the U.K. Coal Board's best customer, the CEGB/SSEB, has been transformed by the introduction of the imaginatively named merry-go-round trains which now carry three quarters of all railborne coal to power plant boilers. Planning, aims and efficiency of the concept of Merry-Go-Round working--a non-stop movement of a permanently coupled set of rail-cars from the colliery to the power plant and back again--are discussed, and the design of the system and the rail-cars is analyzed.

7904 **British conveying equipment in coal mines.** Rogerson, D. (Dowty Meco Ltd, Engl). *Colliery Guardian;* **225**: No. 6, 331-332(Jun 1977).

Transport of coal by conveyors has been a generally accepted feature in British mines for many years. To a large extent this has been due to the geological conditions in Britain which made the longwall method of working essential and, in turn, led to the need for improved methods of continuous coal clearance in the concentrated production districts. Belt conveyors for face work and gate roads became very widely used even before the second world war. Chain conveyors were used for face and auxiliary transport but heavy armored face conveyors did not really make much impact on the British scene until the late 50's. The development of fire resistant belting in both ply and solid woven construction gave an added stimulus to the more general introduction of conveying throughout the mine. This paper emphasizes some basic features of the conveying equipment manufactured by AMBEX members today.

COMBUSTION

REFER ALSO TO CITATION(S) 7803, 8273, 8274, 8946, 8947

7905 (FE—2451-4) **Gas-solids interactions in the distribution zone of a fluidized bed. Phase I. Interim report, December 15—April 30, 1977.** Kirwan, D.J.; Vines, S. (Virginia Univ., Charlottesville (USA)). Oct 1977. Contract EX-76-S-01-2451. 60p. Dep. NTIS, PC A04/MF A01.

The distribution zone of a 60 micron solids fluidized bed was probed with newly-developed miniature, self-heating thermistor probe to define the gas jet, non-moving solids, moving but non-fluidized solids, emulsion and bubble regimes. New data is presented on gas entry velocities of 200 and 300 fps at a superficial velocity of 1 fps and the three dimensional interfaces for the several regimes generated. Comparisons of interfaces for five combinations of entrance and superficial velocities are shown in graphical form. A larger diameter thermistor probe for use in a 6 to 16 mesh crushed limestone bed appears to be operating satisfactorily and is in use to obtain distribution zone data for fluidized bed conditions typical to coal combustors.

7906 (FE—2564-6) **Coal-oil slurry combustion demonstration. Phase I. Monthly report, August 1977.** Dunn, R.M. (New England Power Co., Westborough, Mass. (USA)). Sep 1977. Contract EF-76-C-01-2564. 14p. Dep. NTIS, PC A02/MF A01.

The combustion of a coal-oil slurry in an 80 MW utility boiler originally designed to burn coal but now burning No. 6 oil will be demonstrated. New low pressure air atomized oil burners will be installed. The stability of coal-oil mixtures produced with various commercially available blending equipment is being investigated in the laboratory. Stability is also being evaluated using various dispersant additives. This work will support the selection of coal preparation and slurry blending equipment. This monthly report covers progress from the contract award through August 1977.

7907 (FE—2564-7) **Coal—oil slurry combustion demonstration, phase I. Monthly report, September 1977.** Dunn, R.M. (New England Power Co., Westborough, Mass. (USA)). Oct 1977. Contract EF-76-C-01-2564. 18p. Dep. NTIS, PC A02/MF A01.

Engineering and design activities to date have centered around completion of procurement for installation of the air atomized Forney Verloop burner system into the existing boiler which was designed to burn pulverized coal but converted to residual oil in 1969. Electrical design and procurement including instrumentation to support the January 1978 installation of burners, primary air fans, fuel metering pumps and controls is on the critical path. Design and procurement has begun for the coal oil slurry preparation facility with a target date for operation in September 1978. Design had been held up until slurry samples produced by the Funken mixer, the MICAR mixer, an extruder and a conventional turbine agitator had been analyzed. A public hearing was conducted on July 20, 1977 by the Massachusetts Department of Environmental Quality Engineering (DEOE on NEPSCO's application for a variance to burn 2.2 percent sulfur slurry and to exceed opacity and particulate limits for short periods when burners are initially test fired on coal oil slurry. Based on particulate and opacity levels experienced on No. 6 and the demonstrated relationship between increased fuel sulfur content and improved electrostatic precipitator performance, it is expected that the .12 lb. per million BTU particulate emission limit can be met on Unit No. 1 firing 2.2 percent sulfur slurry at concentrations up to 30 percent coal.

7908 **Combustion of pulverized, solvent-refined coal.** McCann, C.R.; Demeter, J.J.; Bienstock, D. (US ERDA, Pittsburgh Energy Res Cent, Pa). *J. Eng. Power;* **99**: No. 3, 305-308(Jul 1977).

The handling, pulverizing, combustion, and fouling characteristics of solvent-refined coal (SRC) were studied in a multiburner, water-wall furnace designed to burn pulverized, bituminous coal at a rate of 500 lb/hr. The products from two SRC plants, Southern Services, Inc, at Wilsonville, Alabama, and ERDA's plant at Fort Lewis, Washington, were included in the study. SRC obtained from the Southern Services Inc. plant had a fluid temperature less than 300°F while the product obtained from Fort Lewis had a fluid temperature of about 430°F. When operating at secondary air temperatures of 500-600°F it was necessary to water-cool the primary air-coal passages and burner nozzle to prevent melting and subsequent fouling. In addition, secondary air swirl adjustments were made to optimize recirculation and flame shape to overcome burner fouling. Flame temperatures obtained with SRC were several hundred degrees (°F) higher than those measured with bituminous coal, however, NOx emissions were considerably lower than those obtained with coal fired through the more conventional burners originally used in the combustion system. Sulfur oxides emissions of 0.8-1.0 lb $SO_2/10^6$Btu would meet emissions regulations in most air regions in the U.S. Carbon conversion values were similar to those obtained when firing bituminous coal. To provide a basis of comparison, combustion tests were also conducted on a Pittsburgh seam coal, and on Illinois No. 6 coal, the parent coal for the SRC produced at the Wilsonville plant.

7909 **Thermodynamic analysis of the formation of nitrogen and sulfur oxides in the combustion of fuels.** Samuilov, E.V.; Rozhdestvenskii, I.B.; Tsitelauri, N.N.; Gutov, V.N.; Olevinskii, K.K. (G. M. Krzhizhanovskii Power-Engineering Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 31-36(Jul 1977).

Calculated results are given for the equilibrium concentration of oxides of nitrogen and sulfur in the combustion products of various fuels: coal, fuel oil, and natural gas. In all, seven types of fuel are considered, and three kinds of oxidizing agent are used for the combustion of the fuels: air, enriched air, and industrial oxygen. It is found that the content of nitrogen and sulfur oxides depends significantly on the coefficient of oxidizing—agent excess, the temperature, the pressure, and the type of fuel.

7910 **Inert coal macerals in combustion.** Nandi, B.N.; Brown, T.D.; Lee, G.K. *Fuel;* **56**: No. 2, 125-130(Apr 1977).

Pilot-scale pulverized-coal combustion experiments with two western Canadian coals have shown that the combustion efficiencies of the coals were inversely related to the inert contents of the coals, i.e., semifusinite, fusinite and oxidized vitrinite. These macerals were found to persist through the flame in a partially reacted form. The burn-out of a coal with an inert maceral content over 50% was

unaffected by normal changes in combustion conditions; the same changes were successful in improving the burn-out of a coal containing less than 40% inert macerals. Coals with high inert maceral contents produce fly-ash with high levels of unburnt carbon and will require a combination of higher temperatures and higher excess-air levels and longer residence times to achieve combustion efficiencies similar to those of coals with higher reactive-maceral contents. The association of resinitic and bituminous materials with the mineral matter in the Canadian sub-bituminous coal indicated that macerals which contribute significantly to ignition and flame stability are discarded as a washery reject.

7911 Correlation between the exhausting velocity of volatile matters and the heating velocity of fuel particles during combustion. Coroiu, C. *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 1, 147-155(Jan-Mar 1977).

This paper presents analytically and graphically a less known aspect of the solid fuel combustion process, namely the correlation between the exhausting velocity of volatile matters and the heating velocity of particles. Having in view its general implications on the duration and efficiency of pyrolytic processes, the problem is of interest for the combustion, gasification and liquefaction technologies.

7912 Investigation of the behavior of the mineral matter of acid composition in high temperature combustion of coal. Tager, S.A. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 11, 46-49(Nov 1976).

Theoretical and experimental investigations of the combustion of Ekibastuz coal were carried out within a wide range of variation of the process parameters. A full thermodynamic analysis of the composition and properties of the combustion products was carried out. The main factor determining vaporisation of the mineral matter of fuel is temperature. An increase in oxygen concentration in the oxidiser, and change from shortage to excess of oxidiser, decrease vaporisation of the mineral matter. Relatively strong vaporisation of silica can take place only in high temperature combustion chambers operating at a pressure of several atmospheres and a temperature of about 2800K. However, even in this limiting case the vaporised mineral matter will not exceed 30 to 40 percent.

7913 Calculation for determining radiative heat transfer in pulverized coal-fired furnaces. Mikk, I. *Energietechnik;* **26**: 248-250(Jun 1976).

The multizonal method has been simplified by using only one space and one wall zone and equations are developed for calculating the radiative heat transfer. The new method appears sufficiently accurate for most furnace heat transfer problems and saves considerable time in calculation.

7914 Special features of the combustion of particles of solid sintering fuel. Karabasov, Y.S.; Voropaev, E.M.; Valavin, V.S.; Delyagin, G.N.; Kulinich, A.I. (Moscow Steel and Alloys Inst and Miner Fuels Inst, USSR). *Steel USSR;* **6**: No. 5, 229-230(May 1976).

Relationships in the combustion of single particles of brown-coal semicoke, coke from weakly caking coals, coke breeze, and anthracite are examined. Equations have been derived from the experimental data for the dependence of combustion time on the initial particle diameter and the temperature of the atmosphere. Data are given on the ignition temperatures for particles of the given forms of fuel. 1 ref.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 8568

7915 (ARP—35) **Partial enumeration of the external costs to surface coal mining in Southern Appalachia: the case of agriculture.** Vaughn, G.A. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 1975. 34p. of Tennessee, Appalachian Resources Project, Knoxville.

An attempt is made to evaluate the external costs of coal mining in Appalachia by determining the value of agricultural production lost as a result of coal mining. A negative correlation between coal and crop outputs was found, but the correlation could not be definitely attributed to pollution. Forestry and aesthetic losses were considered but could not be definitely related to coal mining. This study suggests that, unless substantial aesthetic losses or other as yet uncounted damages caused by surface coal mine pollution can be documented, society's net wealth would be reduced if surface coal mining were banned. Due to limitations of data and information the conclusions are tentative. (LTN)

7916 (ARP—36) **Industrial organization in the U.S. coal industry since 1965.** Carroll, S.L.; Friedman, D.T. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). May 1975. 79p. of Tennessee, Appalachian Resources Project, Knoxville.

Changes in the USA coal mining industry since 1965 are reviewed from the point of view of economics, industry organization, profitability, productivity, financing and other coal related factors. (LTN)

7917 (ARP—45) **Geographic market areas and market structure in the bituminous coal industry.** Shrieves, R.E. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 1975. 59p. of Tennessee, Appalachian Resources Project, Knoxville.

While the delineation of geographic market areas resulted in more narrowly defined markets than suggested in previous approaches, the use of adjusted price data in confirming those delineations lends a degree of credibility heretofore unattained. In spite of the relatively narrowly defined geographic markets delineated, seller concentration levels were low for areas accounting for the bulk of national coal consumption. These findings on the structural characteristics of the selling side of bituminous coal markets are consistent with conclusions reached elsewhere that the recent surges in coal prices could not be attributed to market power of coal producers. While it appears clear that seller concentration levels are not a significant concern from a national viewpoint, the analyses have identified several geographic regions within the nation (which are specified) where concentration may be considered high enough to warrant special attention for those areas from an antitrust policy standpoint. At the same time, however, the estimates of buyer concentration made in this study would suggest that analysis of price behavior in those markets should be approached with caution, since the high buyer and seller concentration levels admit the possibility of bilateral oligopoly phenomena.

7918 (ERDA—76/129/3) **Synthetic liquid fuels development: assessment of critical factors. Volume III. Regionalized industry; social impact; coal resource depletion.** Dickson, E.M.; Yabroff, I.W.; Kroll, C.A.; White, R.K.; Walton, B.L.; Ivory, M.E.; Fullen, R.E.; Weisbecker, L.W.; Hays, R.L. (Stanford Research Inst., Menlo Park, Calif. (USA)). May 1977. Contract EY-76-C-03-0115. 281p. Dep. NTIS, PC A13/MF A01.

A mathematical model is used to predict for eight U.S. regions the cost of coal extraction and how it will change as resources are depleted. Then the effects of site selection of coal liquefaction plants are calculated. Minemouth siting seeks the lowest cost of coal liquids but is predicted to result in severe boom-bust cycles in the west; dispersion of coal liquefaction plants reduces boom-bust impacts but raises synfuel costs; limited minemouth location of conversion plants offers mid-ground fuel cost and avoids boom-bust cycles. At present there is no mechanism for control of conversion plant siting but severance taxes are suggested as a possibility. In any case half of the remaining U.S. coal is predicted to be used or obligated within 75 years. (LTN)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 8278

7919 (BM-IC—8756) **Laboratory studies on spontaneous heating of coal. A summary of information in the literature.** Kim, A.G. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). 1977. 18p. Dep. NTIS, PC A02/MF A01.

This report summarizes the methods and results of many of the laboratory studies on spontaneous heating of coal published in the last 50 years. It includes a brief description of experimental methods, indices of combustibility, and important contributing factors. Adiabatic calorimetry, isothermal calorimetry, O_2 sorption systems, or temperature differential are the most frequently used experimental methods. Indices of combustibility include various heating rates, crossing point temperature, ignition temperature, and CO index. Factors that affect the spontaneous heating of coal include air flow rate, changes in moisture content, particle size, rank, temperature, pyrite content, geological factors, and mining practice. Experimental conditions and results from 20 papers are summarized in an appendix, and the bibliography contains 45 references.

7920 (CONF-770718—3) **Comparative mutagenesis of test materials from the synthetic fuel technologies.** Epler, J.L.; Larimer, F.W.; Nix, C.E.; Ho, T.; Rao, T.K. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From Symposium on actions of physical and chemical mutagens on the somatic chromosomes of man; Edinburgh, United Kingdom of Great Britain and Northern Ireland (UK) (7 Jul 1977).

In parallel with studies on various families of mutagenic compounds, we have investigated the feasibility of assaying the mutagenicity of crude industrial products and effluents with various test systems. Test materials (crude products from coal liquefaction technologies) were initially fractionated into primary classes by liquid-liquid extraction and then further fractionated by column chromatography. Prescreening was accomplished with the Ames

tester series utilizing histidine reversion in Salmonella. Active fractions (largely the basic fractions containing polycyclic aromatic hydrocarbons) can be identified and dose-response relationships can be established. Standard values are expressed as revertants per mg of starting material assayed with strain TA98 and/or TA100 including metabolic activation with rat liver preparations. Validation and extension of these results to other genetic assays was carried out. Comparative systems include forward and reverse mutation assays in E. coli, yeast, chromatid aberrations in human leukocytes, and gene mutation in Drosophila.

7921 (CONF-771045—1) **Defining an adequate industrial hygiene program for coal conversion technology is a complex problem.** Bolton, N.E. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

From 8. annual conference on environmental toxicology; Dayton, Ohio, USA (4 Oct 1977).

The information was prepared for oral presentation only, and there is no text. Copies of visual aids constitute the entire manuscript.

7922 (PB—267213) **Surveying inhalation contaminants in above ground coal mining and processing work areas (for company safety officers).** Holland, W.D. (LFE Environmental Analysis Labs., Richmond, Calif. (USA)). 5 May 1976. Contract J0255001. 75p. NTIS PC A04/MF A01.

The report is one of a series of instruction guides developed to help instructors present health and safety training courses to workers in the coal mining industry. This course is intended for training those, usually the safety officers, who perform surveys for inhalation contaminants in above ground work areas. The handbook entitled Handbook for Surveys of Inhalation Contaminants in Above Ground Coal Mining and Processing Work Areas (NTIS No. PB-243 358) is used as a manual for the course and as a prime reference when performing the actual surveys or interpreting the sampling results. There are six experiments for the students to perform during the course to familiarize them with the sampling devices routinely used during the surveys.

7923 (PB—267460) **A theoretical and laboratory evaluation of a portable direct-reading particulate mass concentration instrument.** Almich, B.; Solomon, M.; Carson, G.A. (National Inst. for Occupational Safety and Health, Cincinnati, Ohio (USA)). Jul 1975. 40p. NTIS PC A03/MF A01.

A study of the design, construction, performance, and theory of operation of the RDM 101, a prototype instantaneous dust mass concentration monitor. Laboratory performance was judged from the results of coal dust measurements and comparisons in the NIOSH dust chambers. Simulated field performance results are presented from tests involving exposure of the instruments to environmental extremes. An attempt is made to realistically estimate the overall usefulness and applicability of the RDM 101 to the characterization of particulate inhalation hazards in the industrial environment.

7924 **Controlling a quicksand intrusion in the Sophia-Jacoba mine.** Sommer, H. *Glueckauf;* **113**: No. 11, 533-539(2 Jun 1977). (In German).

Use of fiberglass barriers, filtering dams, and sandbags to block the flow of sand is described. Progress of cleaning the shafts and pumping of forcing material out of the mine using hydraulic conveying is discussed. Hydrogeological findings concerning causes of the accident are analyzed. 3 refs.

REGULATIONS

7925 (ARP—32) **Analysis of antitrust activity in the coal industry: 1964—1974.** Hinson, W.R. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 1974. 38p. of Tennessee, Appalachian Resources Project, Knoxville.

During this period antitrust activity by the government in the coal industry was of a token nature and did not prevent (1) large investments in coal and uranium by large oil companies, nor (2) concentration with industry by large companies buying out small companies. A major result was the buying up of coal reserves, which were thus unavailable to small companies and hindered them from competing. Neither the government nor public utility companies did much to deter these developments and the results of the few court suits that were brought were not effective in discouraging the process. In fact, the widespread acceptance of nolo contendere pleas by the judicial system could make it profitable for a coal company to violate the antitrust laws. Several recommendations are made: (1) for more vigorous antitrust activity (with nonacceptance of nolo contendere pleas); (2) nationalisation of coal reserves (with bidding for reserves to be mined by competing companies); (3) a reporting system for ownership of coal reserves; and (4) encouragement of electric utilities to file private suit when anticompetitive behavior is suspected. (LTN)

7926 (PB—268360) **Coal policy or the lack thereof. Final report.** McCullough, D.L. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). Mar 1976. 46p. NTIS PC A03/MF A01.

This report examines certain key policies that have affected the coal industry including proposed strip-mining legislation, air quality standards, restrictions on coal slurry pipelines, and coal land leasing rules.

PETROLEUM

RESERVES

7927 **Oil discoveries in the North Sea.** Ayma, C. (SIKA Co, Fr). *Mater. Tech.;* No. 3-4, 103-106(Mar-Apr 1977). (In French and English).

The quantities of liquid or gaseous hydrocarbons existing in the various sedimentary basins in the North Sea make it the main European oil area and presently the most active investigation zone throughout the world. Most of the fields are located in the northern part of the North Sea, between the 56th and 62nd parellels, but important fields have just been discovered between the 53rd and 54th parallels. Estimated reserves existing in the North Sea include 2.5 billion tons of oil 1.8 of which are in the British sector and 0.6 in the Norwegian sector, 350 million tons of condensates, and 2400 billion cubic meters of natural gas, 1200 of which are in the British sector. The reserves of the North Sea are therefore of the same order as those of Nigeria and slightly lower than those of the Magreb-Lybia. In fact they represent 2.4% of the present estimated world offshore oil reserves or 10% of the Saudi Arabian reserves. The natural gas reserves of the North Sea represent 5% of world reserves.

7928 **Evaluation of the determination of the reserves of totality of small oil deposits.** Bulygin, V.Y.; Bulygin, D.V. (Kazan' State Univ im. V.I. Ul'yanov-Lenin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 21-25(1977). (In Russian).

The problem of evaluation of oil deposit reserves determined by the usual calculation method is considered. A method is proposed to reduce the error rate.

GEOLOGY AND EXPLORATION

7929 **Conodont color alteration: an index to organic metamorphism.** Epstein, A.G.; Epstein, J.B.; Harris, L.D. Washington, DC; US Government Printing Office (1976). 31p. $1.10.

Field and laboratory experiments show that color alteration in conodonts is directly related to the depth and duration of burial and the geothermal gradient and correlates with fixed carbon, vitrinite reflectance, palynomorph translucency, and isopach data. Five progressive and irreversible color changes ranging from pale yellow to black are discriminated. Compilation of color alteration index (CAI) maps for limestones of several ages in the Appalachian basin show: (1) a general systematic change from pale yellow (CAI = 1) to black (CAI = 5) from west to east; (2) within a structural belt, older conodonts are darkest; (3) fixed carbon values determined from coals cannot be directly applied to carbonate rocks; (4) several areas of anomalously low CAI values in windows exposing Ordovician rocks within the Blue Ridge-Piedmont terrane. Data show: (1) color alteration of conodonts is time and temperature dependent; (2) the sequence of color change from pale yellow to black found in field collections is the same as that produced by heating alone; (3) upper and lower geologic temperature limits for each CAI determined from a log time versus reciprocal of absolute temperature plot. Water in combination with confined pressure retards color alteration. The color alteration of conodonts is a valuable tool for assessing organic metamorphism because it is a rapid and inexpensive method requiring only standard laboratory techniques and a binocular microscope. The technique provides thermal cutoffs for oil, condensate, and dry gas generation. Conodont color alteration begins near the upper thermal limit for the preservation of many palynomorphs.

7930 **Offshore oil exploration.** Willm, P. (Inst Fr du Pet). *Mater. Tech.;* No. 3-4, 91-96(Mar-Apr 1977). (In French).

A description is given of offshore drilling equipment developed by the French oil industry with a view to application under the difficult conditions prevailing in the Bay of Biscay and the North Sea. Particular attention is paid to a description of the Pentagone semi-submersible drilling platforms, which consist of five pile-and-

caisson units connected by a bracing system to the deck which supports the drilling equipment at an adequate level above the highest waves. Also described are Pelicane dynamic positioning drilling ship, the Dyposemi dynamic positioning semi-submersible platform, and the Telenaute remote-controlled submarine vehicle.

7931 Efficacy of the hydrogeochemical method in evaluating the prospects of oil deposits discovery (using the example of the West Siberian oil- and gas-bearing basin). Prokop'eva, R.G.; Matusevich, V.M. (Ukhtinsk Ind Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 7-10(1977). (In Russian).

Results of a comparison of hydrogeochemical forecasting with exploratory borehole tests are considered. High efficacy of the hydrogeochemical forecasting of the petroleum and gas potential of a deposit is demonstrated.

7932 Principal results of geophysical oil and gas exploration by the USSR Ministry of Geology during 1971-1975 and main trends of its further development in the tenth 5-year plan period. Fedynskii, V.V. (Mingeo SSSR, USSR). *Geol. Nefti Gaza;* No. 2, 1-8(1977). (In Russian).

Use of new methods and 42 medium-class computers in the exploration work permitted exploration to be conducted at the depths of 5-6 km (Ukraine, Yakutia, and other regions). Difficulties of exploratory work at great depths and in remote regions are pointed out. Concentration of exploration in the most promising regions is urged. In the 1976-1980 period about 1000 structures with the total area of 80,000 km^2 are to be prepared for deep drilling.

7933 Opening up and testing of Lower Cambrian productive strata of East Siberia. Fuks, B.A.; Kazanskii, V.V.; Moskalets, G.I.; Fuks, A.B.; Yakovenko, F.N. (East Sib Sci Res Inst of Geol, USSR). *Geol. Nefti Gaza;* No. 2, 13-18(1977). (In Russian).

A brief characterization of the collecting properties of reservoir strata singled out in a section of the Lower Cambrian deposits of East Siberia is given. In the majority of cases, a NaCl solution was used when boreholes were drilled and considerable absorption was noted. This had a negative effect on the filtration characteristics. The reservoir strata become clean during the operation of the boreholes and the harmful effect of the solution is eliminated. Recommendations are given on the tapping and testing of the reservoir strata of different quality and type.

7934 Improvement of geological efficacy of exploration by perfecting interpretation of seismic exploration data in a tridimensional space. Glotov, O.K. (Geophys Inst, USSR). *Geol. Nefti Gaza;* No. 2, 33-37(1977). (In Russian).

Using a precisely calculated seismic model of a two-layered medium imitating a buried spherical salt dome and an inclined-plane subsalt boundary, substantial distortions of structural forms in space owing to incomplete consideration of the seismic drift in space, with interpretation of data by the common-deep-point method, in structurally complex tectonic regions, are shown. The advantages of a new graph and analytical "center rays" method tested in the Pripyat and Caspian depressions is demonstrated. The results obtained on a model explain false mapping of a closed structure under the Ulkentyube dome in the Caspian depression. It is shown that, when using this method, seismic drift has to be taken into account when the angles of dip of horizons exceed 10$degree$.

7935 Some results of mathematical modeling of petrophysical parameters of terrigenous rocks of the northwest edge of the South Caspian Depression. Dzhevanshir, R.D. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 11-16(1977). (In Russian).

Results of mathematical modeling of curves of variation of porosity, permeability and density of clays and reservoir rocks of the NW edge of the South Caspian Depression down to the depth of 9000 m are presented. It is concluded that the coefficient of anomality of porous pressure in clays at the depths of more than 6000 m probably declines. 9 refs.

7936 Petroleum and gas potential of lower horizons of the productive strata of the Kyursangya Deposit. Gyul'dust, M.A.; Guseinov, G.M.; Adzhalova, S.S. (Az SSR Inst of Pet and Chem im. M. Szizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 17-20(1977). (In Russian).

The character of the oil and gas bearing potential of the lower part of the productive series is considered in connection with the reservoir properties of rocks and the tectonic structure of the Kyursangya fold.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 7930, 7997, 8899

7937 (SAN/1396—6) Improved secondary oil recovery by controlled water flooding-pilot demonstration ranger zone, fault block VII, Wilmington field. Phase I. Quarterly report, January—March 1977. (City of Long Beach, Calif. (USA)). 18 Apr 1977. Contract EF-76-C-03-1396. 23p. Dep. NTIS, PC A02/MF A01.

Operations in improved caustic waterflooding in a typical, well flood pattern of the Ranger Zone of the Long Beach Unit portion of the Wilmington Field are reported. The redrill, coring and special logging of pilot area injection well B-110-IA was completed; the well is now being completed using a remedial rig in lieu of a drilling rig. Producing well B-712 was repaired with an inner liner and then selectively stimulated thermally. Injector B-709-I had dual injection strings installed. Injector B-119-I was thermally stimulated over the entire Ranger interval. Testing of cores from B-827-A continued, but at a slower pace than anticipated. Laboratory core and crude handling problems are in part to blame for this delay. However, the delay due to uncertain availability of a drilling rig is felt to be more controlling. The facility design, procurement and installation work is proceeding on schedule. Facilities for the mini-injection test are in place, but the test of B-836-I will be delayed pending completion of nearby injection well repair work. Laboratory results indicate oil-water dehydration will not be a problem with the caustic flood, but clean-up of the produced water for re-injection may.

7938 Pumping device for wells, such as oil wells. Chardonneau, J.; Sable, C. (to Centre d'Etudes et de Realisations Industrielles de l'Atlantique (Ceria)). US Patent 4,052,907. 11 Oct 1977. Priority date 23 Jan 1975, France. 6p.

The invention concerns pumping apparatus for wells, such as oil wells, comprising a framework constituted by a tubular mast, a driving plant, a linkage connectable to a force pump immersed in the well, a flexible connection between the said plant and the said linkage for transmitting and imparting a reciprocating lifting and lowering movement to the rod linkage to actuate the force pump, the tubular mast including, for the connection to the rod linkage, guide pulleys with horizontal axes of rotation, and a lockable arm for carrying the guide pulleys and mounted for pivoting on the tubular mast about a vertical axis. 7 claims, 8 drawing figures.

7939 Measuring reservoir oil saturation. Murphy, R.P.; Owens, W.W. (to Standard Oil Co. (Indiana)). US Patent 4,052,893. 11 Oct 1977. Filed date 29 Sep 1976. 8p.

A procedure is described for obtaining data to determine both residual and mobile oil saturations in the vicinity of a test well. The steps are (1) drill with oil or oil-base mud, (2) produce to remove oil filtrate, (3) run laterlog, microlaterolog and pulsed neutron capture log, (4) inject high salinity water, (5) run a second microlaterolog and pulsed neutron capture log, (6) inject fresh water, and (7) run a third pulsed neutron capture log. The data obtained from the logs of the procedure is sufficient to determine the residual oil saturation, the capture cross section of the rock matrix, the saturation exponent, the salinity of the water in the formation after production, and mobile oil saturation both in the oil filtrate invaded zone and beyond the invaded zone. 6 claims, no drawings.

7940 Oil well pump with plunger pull down and desanding assembly. Sparks, V.H. Sr. US Patent 4,049,365. 20 Sep 1977. Filed date 13 Sep 1974. 14p.

A pump of the reciprocating plunger type for an oil well is designed in which structure is provided for pulling downwardly on the pump plunger during its downward stroke rather than relying upon the pump rod or sucker rod to push the plunger downwardly, thereby reducing wear and damage. One embodiment involves a tension member connected with the walking beam and extending downwardly below the plunger, around a roller assembly or the like and then back upwardly for connection with the bottom of the plunger so that as the walking beam moves downwardly to move the pump plunger downwardly, the tension member will be tensioned for pulling the plunger downwardly without applying compressive force to the pump rod or sucker rod. Another embodiment provides a weight attached to the bottom of the plunger with the weight being reciprocal in a closed chamber so that it is not in contact with the fluid being pumped. The pump barrel is provided with a desander between the plunger and the standing valve and is in the form of a rod projecting upwardly in the pump barrel for extending into the lower hollow end of the pump plunger for removing sand therefrom to prevent sand from filling or clogging the lower end of the plunger. 6 claims, 17 drawing figures.

7941 Paraffin cleaner. Hewes, W.S. US Patent 4,049,057. 20 Sep 1977. Filed date 30 Sep 1976. 8p.

A valve unit is placed in the eduction tube of an oil well. The unit has two valves therein, one to discharge fluid from the eduction tube into the annulus between the tube and the casing and the other to receive fluid from the annulus into the eduction tube. The ball of the valves are held against a seat by cupped or "Belville" washers. The valves are located within an enlarged cylindrical portion of the eduction tube. 7 claims, 6 drawing figures.

7942 Oil and gas well stimulation. Godfrey, C.S. (to Physics International Co.). US Patent 4,049,056. 20 Sep 1977. Filed date 28 Jun 1976. 14p.

A method for stimulating oil and gas wells to increase production comprises filling the lower portion of the well above the pay zone level having exposed rock with a fracturing fluid, and sealing the well above the lower portion. A shock wave is then applied to the fracturing fluid which, when applied thereby to the rock at the pay zone, creates a stress wave in the rock having a rise time faster than the time required for sound to traverse one half the periphery of the rock at the pay zone, and having an amplitude which will fracture but not crush the rock. 17 claims, 11 drawing figures.

7943 Recovery of hydrocarbons from partially exhausted oil wells by mechanical wave heating. Fisher, S.T.; Fisher, C.B. US Patent 4,049,053. 20 Sep 1977. Filed date 10 Jun 1976. 10p.

Underground viscous hydrocarbon deposits, such as the viscous residues in conventional oil wells, are heated by mechanical wave energy to fluidize the hydrocarbons thereby to facilitate extraction thereof. For uniform, circular, symmetrical dispersion of mechanical wave energy of high-power and low-frequency, a mechanical wave energy radiator is provided comprising a cylindrical elastic tube of springy steel or the like preferably dimpled or corrugated and closed at one end and containing a liquid medium. Mechanical wave energy is applied to the liquid medium by a reciprocating source or the like connected to the radiator by a rigid walled tubular pipe or the like. The axial length of the radiator tube should be an odd multiple of one-quarter wavelength of the mechanical wave energy transmitted. Cavitation within the liquid is avoided by biasing the system with a steady state pressure at least as great as the maximum negative pressure swing of the mechanical waves in the liquid. Transformers are disclosed for accommodating changes in pipe diameter and changes in liquid medium throughout the system. 13 claims, 10 drawing figures.

7944 Aqueous clay base mud for deep drilling. Engelhardt, F.; Hille, M.; Ulmschneider, D. (to Hoechst AG). US Patent 4,048,077. 13 Sep 1977. Priority date 14 Sep 1974, German, Federal Republic of (F.R. Germany). 8p.

An aqueous clay base mud for deep drilling contains as a protective colloid a copolymer which is constituted by (I) $(R_1CHCHSO_3^- Me^+)$/sub x/, (II) (R_2CHCHR_3)/sub y/, and (III) $(CH_2 - CH(NR_5)COR_4)$/sub z/, in which R_1 and R_2 each is hydrogen of $-CH_3$; R_3 is $-CO-NH_2$, -CN or $COOCH_3$; R_4 is hydrogen, $-CH_3$ or $-C_2H_5$; R_5 is $-CH_3$ or $-C_2H_5$ or R_4 and R_5 together represent a propylene group forming a pyrrolidone radical with the inclusion of the radical -NCO-; Me is ammonium, potassium, sodium or lithium and x is 5 to 50, y 25 to 92 and z 3 to 70, or by the saponification products thereof and which contains the components in the parts by weight of the starting monomers indicated by the indices x, y and z. 4 claims, no drawings.

7945 Resolution of through tubing fluid flow and behind casing fluid flow in multiple completion wells. Arnold, D.M. (to Texaco Inc.). US Patent 4,047,028. 6 Sep 1977. Filed date 3 Nov 1975. 26p.

A method is provided for resolving undesired fluid flow in cement channels behind casing in one producing zone of a multi zone completion well operating on gas lift from the fluid flow from lower producing zones in the same well which is contained in production tubing passing through the producing zone being investigated. Gamma rays which are characteristic of the decay of the unstable isotope nitrogen 16 produced by activation of elemental oxygen nuclei comprising the molecular structure of both the tubing fluid flow and the undesired fluid flow are detected in at least two energy bonds at two longitudinally spaced detectors in a well borehole. By appropriately combining the four count rate signals so producing according to predetermined relationships the two fluid flow components in the same direction may be uniquely distinguished on the basis of their differing distances from the gamma ray detectors. 9 claims, 17 figures.

7946 Subsurface-controlled valves more reliable. *North. Offshore;* **6**: No. 5, 12-13(May 1977).

The evidence gathered during the past ten years indicates that subsurface-controlled valves are more reliable than surface-controlled valves. Subsurface-controlled valves are located at the bottom of the well and depend on the flow rates or the pressure through them to close or stay open. Basic problems with subsurface safety valves, and the procedures in blowout prevention are outlined.

7947 Condeep ballast system. *North. Offshore;* **6**: No. 5, 33, 35-36(May 1977).

This article describes a sophisticated ballast system designed and built by Norway's Kvaerner Engineering A/S for the Condeep platform TCP-2 in the North Sea's Elf field. The ballast system ensures correct draft when submerging the platform during deck mating and equipment lift-on, on tow-out and lowering at location on the field, as well as during the foundation work.

7948 American multi-well platform for hostile areas. *North. Offshore;* **6**: No. 5, 47-49, 53(May 1977).

A totally new type of production platform in steel, described as a multi-well oil production platform for hostile offshore environment, is featured here. Recently introduced by Bethlehem Steel Corp., the platform is of the mat-supported, jack-up, gravity type. Once installed, the platform is almost immediately ready to go into operation. The entire structure is made of steel, thereby reducing the weight and permitting use on much poorer soils.

7949 Surface-active agents for tertiary oil recovery: Selection criteria and selection methods. Akstinat, M.H. (Tech Univ, Clausthal, Ger). *Tenside;* **14**: No. 2, 57-63(Mar-Apr 1977). (In German).

This paper deals with the main selection criteria for surface-active compounds used for tertiary oil recovery. The solubility phenomena, adsorption, interfacial tension, pH, stability and costs are discussed in detail. Besides the centrifugal testing for petroleum displacement a new rapid selection-method is proposed. 29 refs.

7950 Design of offshore structure. Susbielles, G. (Inst Fr du Pet). *Mater. Tech.;* No. 3-4, 97-102(Mar-Apr 1977). (In French).

It is shown how further improvement in offshore platform design is dependent on knowledge of the marine environment, including wave energy spectra, ice formation, and sea floor structure; studies of the effect of wave-induced forces on platform structures; and studies of platform material strength, including mathematical models.

7951 Steel in offshore oil exploitation. Bourdillon, F. (Metall d'Usinor, Fr). *Mater. Tech.;* No. 3-4, 185-189(Mar-Apr 1977). (In French).

A survey is made of the principal uses of steel in all types of structures required for offshore oil exploration. This survey covers steel platforms of fixed or mobile type, steel tanks, large-diameter welded steel pipe, steel casing and production pipes, steel drill pipes, steel used in oil tankers, and steel used in diving systems.

7952 Liquid hydrocarbon production in the United States, 1946-75 and 1980 projected, highlighting enhanced recovery. Carrales, M. Jr.; Funk, V.T. Washington, DC; Bureau of Mines (1977). 78p.

This publication presents short-range projections of domestic liquid hydrocarbon production through 1980. Appraisal of future crude oil production was made by evaluating the relationship between primary and enhanced oil recovery and the total crude oil producing trends in each of the oil-producing areas of the United States. Future natural gas liquid production was generally estimated by projecting historical production. From 1975 to 1980, crude oil production for the conterminous United States is expected to decline from 7.8 to 6.4 million barrels of oil per day (BOPD), and it is expected to increase from 8.1 to 8.2 million BOPD for the total United States. However, these estimates do not include additional production expected from the Elk Hills field in California and the Yates field in Texas. If included, 1980 production for the conterminous United States would be 6.7 million BOPD and 8.4 million BOPD for the total United States. 7 refs.

7953 Problem of calculation of thin-walled casing pipes in the cemented part of wells. Mochaernyuk, D.Y.; Piskozub, L.I. (L'vov Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 27-32(1977). (In Russian).

Problem of stability of a set form of equilibrium of thin-walled cylindrical pipes under the effect of external hydrostatic pressure is solved taking into account the elastic resistance of the environment. The problem is solved for several variants of design schemes (with and without accounting for the cohesion between the cement ring with a pipe and the well walls). Calculations show that numerical values of critical pressures for tubes in the cemented zone depend on the relation between the rigidity of the pipes and the cement shell, as well as on the reliability of cohesion between the elements of the casing and the well walls.

7954 A. Lubinsky's results and energetic approach in solving the problem of static deflection of a string of drill pipes in a well. Griguletskii, V.G. (Groznyi Pet Inst im. M.D. Millionshchikov, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 33-36(1977). (In Russian).

A. Lubinsky's results on the determination of critical loads are discussed. A new method of solving this problem is proposed. It makes use of the concept of the "reduced" load, the magnitude of which is established from the results of "energetic solution" of similar problems.

7955 Effect of borehole grid density on the rate of petroleum extraction. Movmyga, G.T. (Groznyi Pet Inst im. M.D. Millionschchikov, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 40-44(1977). (In Russian).

Results of an investigation of the current, maximum, and average (during the main period of exploitation) rate of petroleum extraction depending on the density of the borehole grid, determined by the respective number of actually functioning wells, for 18

deposits of Checkeno-Ingushetia and Azerbaijan, exploited for long periods of time, are presented. It is shown that, for the majority of the strata considered, it was sufficient to have a borehole grid of 16-24 hectare/well to attain the maximum rate of petroleum extraction.

7956 Problem of approximation of the transfer function of a string of drill pipes. Kadymov, Y.B.; Iovnovich, B.I. (Az SSR Polytech Inst im. Ch. Il'dryma). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 81-84(1977). (In Russian).

A method of approximation of the transfer function of a string of drill pipes is proposed. The string of drill pipes is considered as a member with distributed parameters taking into account losses and loads in the form of an impulse transfer function.

7957 Investigation of the transient temperature and temperature stresses in the friction pair of the draw works brake. Faradzhev, T.G.; Guseinov, I.B.; Aliev, A.M.; Alikhanov, N.R. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 91-95(1977). (In Russian).

The value of the differnce between thermal stresses of a brake pulley is determined. It is shown that, in order to prevent cracking and plastic deformations of the brake pulley, it is necessary to use cooling systems that minimize the differences between thermal stresses.

7958 Distribution of contact pressure along the axis of the sleeve-plate joint of a drive chain. Aliev, L.F.; Arustamova, R.S.; Ragimov, A.S.; Allakhverdiev, R.A. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 97-100(1977). (In Russian).

Results of a theoretical investigation into the character of distribution of contact pressure along the sleeve-plate conjugation of a drive chain are presented. Analytical relations for determining the contact pressure are given.

7959 Economico-mathematical modeling of optimal functioning and management of a drilling enterprise. Mishina, K.I.; Pirverdiev, C.A. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 107-112(1977). (In Russian).

A mathematical model is proposed for the determination of optimal parameters in the subsystem of current planning and management of a drilling enterprise. Optimality criteria in solving problems of this kind are justified.

7960 Salt-resistant chalk muds. Aminov, A. (Tashkent Polytech Inst, Uzb SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 1, 27-28(1977). (In Russian).

A report is presented on experimental investigations of properties of ordinary and heavier-type drilling fluids prepared from bentonite and hydromica clays, as well as from chalk, adding to them polyacrylamide and for comparison, other additives. It is shown that polyacrylamide is an effective stabilizer of chalk muds in conditions where sodium, magnesium and calcium chloride layers are present in the rocks drilled.

7961 Selection of coated electrodes for welding offshore constructions. Jonassen, R.L. *Norgas Tidsskr Sveising Skjeering;* **40**: No. 1, 2-9(1976). (In Norwegian).

After a short summary of the problems posed by the welding of offshore structures, especially tubular joints, two types of basic electrodes are described which have been perfected for the welding of steels for offshore platforms. One of the electrodes corresponds to the designation AWS/ASTM E 8018-C1 (Lloyd's 3. 111. H). Results of COD and Charpy tests are given.

PROCESSING

REFER ALSO TO CITATION(S) 7992, 8023

7962 (PB—267555) **Chemically active fluid-bed process for sulphur removal during gasification of heavy fuel oil - second phase.** Craig, J.W.T.; Johnes, G.L.; Moss, G.; Taylor, J.H.; Tisdall, D.E. (Esso Research Centre, Abingdon (UK)). Nov 1973. Contract EPA-68-02-0300. 208p. NTIS PC A10/MF A01.

The report describes the second phase of studies on the CAFB process for desulfurizing gasification of heavy fuel oil in a bed of hot lime. The first continuous pilot plant test with U.S. limestone BCR 1691 experienced local stone sintering and severe production of sticky dust during startup. Batch tests confirmed that BCR 1691 produced more dust than the purer Denbighshire or U.S. BCR 1359 stones. With BCR 1691, 10 times more dust was produced during kerosene combustion at 870C than during gasification/regeneration. The continuous pilot plant was modified to improve operability under dusty conditions: 332 gasification hours were spent in a second run with Denbighshire and BCR 1691 stones in six operating periods, the longest being 109 hours. Sulfur removal efficiency was comparable for the two stones, ranging from 60 to 95%. Regenerator performance was less satisfactory than in earlier tests. A poor sulfur material balance indicates need for improved analytical procedures. Total CAFB development through a large demonstration test will probably take about 6-7 years and require $3,320,000 in engineering effort.

7963 Process for producing isoparaffin-olefin alkylate having improved octane number. Hutson, T. Jr. (to Phillips Petroleum Co.). US Patent 4,053,535. 11 Oct 1977. Filed date 25 May 1976. 4p.

An isoparaffin—olefin alkylate of improved octane number is produced by passing total hydrocarbon reactants through a static mixing zone prior to passing the reactants to a riser-reactor admixed with HF acid catalyst. The total hydrocarbon reactants include HF-free isoparaffin recycled stream.

7964 Hydrodesulfurization process employing a guard chamber. Paraskos, J.A.; Yanik, S.J. (to Gulf Research and Development Co.). US Patent 4,053,391. 11 Oct 1977. Filed date 17 Nov 1975. 12p.

A process for hydrodesulfurizing a residual oil comprises passing the oil downwardly through a catalytic reaction zone at a hydrogen pressure which is sufficiently high that demetallization occurs rapidly so that at end-of-run the upstream catalyst region is more nearly metals-saturated than the downstream catalyst region. At the end of the catalyst cycle, the more nearly metals-saturated upstream portion of the catalyst is removed from the process while the less nearly metals-saturated downstream portion of the catalyst is passed to a guard chamber where during further operation of the process it approaches metals-saturation. In this manner, no portion of catalyst is removed from the process until it has an elevated metals content. 6 claims, 5 drawing figures.

7965 Start-up procedure for a residual oil processing unit. James, L.C. (to Cities Service Research and Development Co.). US Patent 4,053,390. 11 Oct 1977. Filed date 17 Dec 1975. 4p.

In starting up an upflow, ebullated bed hydroprocessing reactor, a light oil is used to establish an ebullating bed. As heavy residual feedstock is incrementally substituted, the ebullating pump speed and gas flow rate need to be monitored and adjusted for smooth operation. By knowing and controlling the viscosity and density of the feedstock, flow variations inside the reactor can be minimized, resulting in a constant pump speed and gas flow rate. 1 claim, no drawing figures.

7966 Hydrocarbon conversion with an acidic multi-metallic catalytic composite. Wilhelm, F.C. (to UOP Inc.). US Patent 4,053,389. 11 Oct 1977. Filed date 8 Sep 1975. 20p.

Hydrocarbons are converted by contacting them with an acidic multimetallic catalytic composite comprising a combination of a platinum or palladium component, a rhodium component, a rhenium component, a lead component, and a halogen component with a porous carrier material. The components are present in amounts corresponding to about 0.01 to about 2 wt. % platinum or palladium metal, about 0.01 to about 2 wt. % rhodium, about 0.01 to about 2 wt. % rhenium, about 0.1 to about 3.5 wt. % halogen, and an atomic ratio of lead to platinum or palladium of about 0.05 : 1 to about 0.9 : 1. Moreover, these metallic components are uniformly dispersed throughout the porous carrier material in carefully controlled oxidation states such that substantially all of the platinum or palladium component is present therein in the elemental metallic state; substantially all of the rhenium and rhodium components are present therein in the elemental metallic state or in a state which is reducible to the elemental metallic state under hydrocarbon conversion conditions or in a mixture of these states and substantially all of the lead component is present in an oxidation state above that of the elemental metal. A specific example of the type of hydrocarbon conversion process disclosed is a process for the catalytic reforming of a low-octane gasoline fraction wherein the gasoline fraction and a hydrogen stream are contacted with the acidic multimetallic catalyst disclosed herein at reforming conditions. 16 claims, no drawings.

7967 Extractive distillation. Cines, M.R. (to Phillips Petroleum Co.). US Patent 4,053,369. 11 Oct 1977. Filed date 24 Nov 1976. 18p.

In a process of extractive distillation, the combination of operating with two liquid phases in at least the uppermost trays of the column, preferably while maintaining the column operation at substantially an optimum reflux ratio, results in increased efficiencies and minimum requirements for selective solvent. 21 claims, 5 drawing figures.

7968 Temperature control of integrated fractionation and clay-treating of hydrocarbons. Gewartowski, S.A. (to UOP Inc.). US Patent 4,053,367. 11 Oct 1977. Filed date 24 Jan 1977. 14p.

A hydrocarbon stream comprising benzene is stripped at a high temperature to allow passage of the stripper bottoms stream into a clay treating zone without further heating, and the effluent of the clay treating zone is then exchanged against the feed stream to the stripper column to recover heat. Operation at the optimum clay treating temperature is achieved by adjusting the amount of the stripper bottoms stream which is split off for cooling by heat

excharge against the feed to the stripper column. The cooled split-off portion is then admixed with the remaining high temperature portion. Adjusting the flow rate of the portion of hot clay treater effluent which is heat exchanged against the stripper feed stream is performed to control the temperature of either the stripper feed stream or the temperature of the clay treater effluent as it is passed into a downstream fractionator. 10 claims, 1 drawing figure.

7969 Reduction of sulfur from hydrocarbon feed stock containing olefinic component. Gibson, K.R.; Hughes, T.R.; Jacobson, R.L. (to Chevron Research Co.). US Patent 4,049,542. 20 Sep 1977. Filed date 4 Oct 1976. 6p.

A hydrocarbon feed containing an olefinic component and sulfur-containing impurities is upgraded in a sulfur removal process without hydrogenating the olefins by contacting a mixture of the feed and hydrogen gas with a catalyst comprising copper under conditions, including a temperature in the range of about 120 to 400°C. 10 claims, no drawings.

7970 Two-stage hydrodesulfurization of oil utilizing a narrow pore size distribution catalyst. Riley, K.L. (to Exxon Research and Engineering Co.). US Patent 4,048,060. 13 Sep 1977. Filed date 29 Dec 1975. 14p.

A two-stage hydrotreating process is provided in which a heavy hydrocarbon feed is treated with hydrogen and a small pore catalyst in a first zone and the hydrotreated hydrocarbon product is treated in a second zone with hydrogen and a larger pore catalyst having a specific pore size distribution. 23 claims, 5 drawing figures.

7971 Methods to be used in reforming processes employing multi-metallic catalysts. Petersen, R.D.; Mieville, R.L. (to Standard Oil Co. (Indiana)). US Patent 4,048,058. 13 Sep 1977. Filed date 9 Oct 1975. 14p.

A method is disclosed for sulfiding a multi-metallic catalyst or a bi-metallic catalyst and a method for initiating the reforming of a petroleum hydrocarbon feedstock in a reforming reaction zone containing a multi-metallic catalyst or a bi-metallic catalyst. The method for sulfiding is employed when a hydrogen-rich gas containing light hydrocarbons is used in the sulfiding of the catalyst. The method comprises passing a stream of said gas over said catalyst at a temperature of 350 to 470°F, injecting a sulfur-containing compound into the stream of gas upstream from said catalyst in order to provide a sulfur-carrying gas, and contacting said catalyst with said sulfur-carrying gas at said temperature for a time that is sufficient to provide a sulfur concentration on said catalyst of about 0.1 to about 2.5 moles of sulfur per mole of total active metal. A typical sulfur-containing compound is dimethyl sulfide. 39 claims, 1 drawing figure.

7972 Integrated heavy oil cracking process utilizing catalyst separated from cracking in pretreating zone. Murphy, J.R. (to Pullman Inc.). US Patent 4,048,057. 13 Sep 1977. Filed date 4 Oct 1976. 18p.

An integrated process is described wherein a heavy oil catalytic cracking unit is integrated with a pretreating zone. In the pretreating zone, petroleum feedstock is contacted, in the presence of hydrogen, with used equilibrium catalyst purged from the cracking zone to reduce the metals, carbon residue, and sulfur content of the petroleum feedstock prior to charging the feedstock to the cracking zone of the heavy oil catalytic cracking unit. 17 claims, 3 drawing figures.

7973 Solvent extraction. Forbes, E.S.; Reid, A.J.D. (to British Petroleum Co., Ltd.). US Patent 4,045,332. 30 Aug 1977. Priority date 14 May 1975, United Kingdom of Great Britain and Northern Ireland (UK). 8p.

The degradation of furfural, used in the solvent extraction of aromatics, is inhibited by the use of a furfural-soluble, recoverable amine having a pK/sub a/ greater than that of aniline. The preferred amine is N,N-diethyl aniline and the amount used may be 0.001 to 5% wt, preferably 0.01 to 2% wt. by weight of furfural. The recoverable amine may be used in combination with a non-recoverable amine, e.g., tri-ethanolamine, the amount of non-recoverable amine being preferably 1 to 1000 ppM wt, particularly 5 to 50 ppM. 7 claims, 1 drawing figure.

7974 Catalysts for hydrocarbon conversion. Juguin, B.; Cosyns, J.; Le Page, J.F.; Miquel, J. (to Societe Francaise des Produits pour Catalyse). US Patent 4,043,944. 23 Aug 1977. Priority date 11 Oct 1974, France. 12p.

A new catalyst is comprised of a carrier such as alumina, platinum, at least one metal selected from iridium, tungsten and ruthenium, cobalt, at least one metal selected from the group consisting of copper, manganese, silver and gold, and at least one halogen such chlorine.

7975 Removal of acidic gases from hydrocarbon streams. Foster, P.C.; Humphries, J.J. Jr. (to Stone and Webster Engineering Corp.). US Patent 4,041,129. 9 Aug 1977. Filed date 23 Jul 1974. 8p.

An apparatus and process for substantially reducing carbon dioxide and/or hydrogen sulfide levels in a hydrocarbon gas with simultaneous regeneration of reagent materials are disclosed. The process consists of passing the gas through an aqueous sodium hydroxide solution, reacting the effluent liquid with an acidic reagent, stripping the acidic gases therefrom and subjecting the resulting aqueous sodium sulfate solution to an electrolytic process. The apparatus used to carry out the process comprises an acidic gas absorbing unit, means for reacting the resulting effluent liquid, means for stripping the acidic gases and an electrolytic cell to convert soluble alkali metal salts into the corresponding alkali metal hydroxide and acidic reagents. 17 claims, 2 figures.

7976 Determination of the output of coke when coking heavy petroleum residues. Salimova, N.A.; Zeinalov, F.I.; Mirzoev, S.D. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 26(1977). (In Russian).

A method of simultaneous coking of several samples of heavy oil residues with determination of the output of all the coking products is presented. A diagram of the laboratory coking apparatus is given. Uniform heating of petroleum products is ensured by a quartz/air fluidized bed.

7977 Selection of the method of coke heating in multistage fluidized bed ovens. Voloshin, N.D.; Proskurnov, V.E.; Trukhan, Y.M.; Zel', G.L.; Teterin, M.A.; Lizunov, A.N. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 57-58(1977). (In Russian).

An analysis of a method of heating coke fines in a fluidized bed is presented. This method is envisaged for a pilot industrial plant for petroleum coke calcination. The shortcomings noticed during a test run are pointed out. To eliminate these shortcomings in the heating of coke fines, some changes in the heating system are proposed.

7978 Diagram of state of two-component flows. Dzyadzio, A.M.; Kostyuk, G.F.; Salamakha, V.I. (Odessa Technol Inst of Food Ind im. M.V. Lomonosov, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 65-68(1977). (In Russian).

The diagram of state of two-component flows (air-solid) is considered not only as a relation between the resistance and velocity of air, but the effect of the velocity of air on maximum productivity of the pneumatic transport is presented. It is shown experimentally that, under appropriate conditions it is possible to obtain different states of the friable mass by increasing the air flow velocity, namely: immobile, expansion, transport by pistons, and at "low" concentrations. The diagaram of state permits selection of aerodynamic parameters to obtain better optimal conditions for the process of catalytic cracking.

7979 Use of mathematically designed experiments in petroleum refining and petrochemicals. Popov, A.A.; Nazarov, V.I.; Khots, M.S.; Lerman, A.G.; Granovskii, Y.V. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 663-666(Sep-Oct 1976).

The complexity of the reactions involved in the destructive processing of hydrocarbon mixtures makes it difficult to set up analytical mathematical models, so that scientists in developing new manufacturing processes are forced to resort to experiment. Laboratory, pilot-plant, and semicommercial units and specially designed test stands are built in order to obtain objective indices of the process. Under these conditions, correct formulation of the experiment and the elimination of noninformative experiments are extremely important. By organizing the experimental work on the basis of mathematical methods and the use of computers, greater results are obtained from a given amount of work on the part of the investigator; also, the time required for completion of the work is reduced, and the scientific level of the work is raised. This paper reports some aspects of mathematical design of experiments (MDE) relevant to the Russian research programs in the petroleum field. 17 refs.

7980 Problem of creating a computerized system for the development of process specifications as an integral part of an No-Asu(Scientific Research Automatic Control System). Timofeev, G.A.; Sokolov, B.I.; Pilyavskii, V.P. (All-Union Sci-Res Inst of Petrochem Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 667-670(Sep-Oct 1976).

For a Branch institute engaged in the development of petrochemical manufacturing processes, a marked increase in productivity, efficiency, and quality of work is possible only through complex automation of the entire cycle of research and development operations--from the performance of the initial experiments to the issue of the process specifications (PS). A modern system of automated research must be based on a complex of automatic experimental and pilot units that supply the primary information directly or through intermediate carriers to a large computer (ES 1040, ES 1050) for processing and interpretation of this information, which is organizationally formulated as a PS issue. Conceptual unity of the system is ensured by solving the problem of organizing the original experi-

mental information and ensuring that this information will be of high quality; this problem must be solved before starting the development of the system. Solution of the problem consists of standardizing the original experimental information and developing algorithms for the processing of this information. 3 refs.

7981 Automated system for processing data from mass spectrometry. Khots, M.S.; Lerman, A.G.; Kogan, L.O.; Polyakova, A.A.; Popov, A.A.; Vasilenko, G.V. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 679-681(Sep-Oct 1976).

Mass spectrometric analysis is a highly informative method for investigating products from petroleum refining and petrochemical manufacture, since the mass spectra that are obtained give a rather complete reflection of the qualitative and quantitative composition of the products being investigated. Manual workup of a large number of spectra is laborious and counterproductive and leads to a considerable lag in obtaining the results. Thus, the use of computers in processing the data from mass spectrometric analysis is an urgent matter. It must be noted that manual transcription of mass spectrometric information to a passive carrier for computerized operations is also an extremely laborious task. In resolving this matter of machine processing of mass spectra, the authors have set up and are currently operating, on an experimental basis, a complex consisting of mass spectrometer/minicomputer/Minsk-22 computer. Details of the system are given along with its operation techniques. 2 refs.

7982 Determination of content of rare-earth oxides (REO) in zeolites and in zeolite-containing catalysts. Poezd, N.P.; Volynkina, N.K. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 731-734(Sep-Oct 1976).

The most active and stable cracking catalysts are aluminosilicates with added zeolites in the rare-earth form. The determination of total REO in these catalysts is performed gravimetrically, based on precipitation of the REE in the form of the oxalates. Also used in determining REO is a method involving complexometric titration in the presence of xylenol orange indicator, using sulfosalicyclic acid as a masking agent for the aluminum cation. Spectrophotometric methods are also used in this determination, as they are the fastest and most accurate. A procedure has been reported for determining REE in ores with Arsenazo III after preliminary recovery of the REE in the form of the oxalates and dissolution of the calcined oxides in 0.01 N hydrochloric acid. In the reported study the authors have investigated the possibility of determining REO content in zeolites of the rare-earth form and in zeolite-containing catalysts without any preliminary separation of the REO in the form of oxalates, i.e., in the presence of aluminum and alkali metal cations. They have also investigated the influence of the acidity of the original solution (when adjusted to the proper level with caustic) on the stability of the light-absorbing complex of the REO with Arsenazo III. Results of an experimental analysis are presented and evaluated. 6 refs.

7983 Conversion of normal paraffinic hydrocarbons over high-fluorine catalyst. Sariev, I.; Penchev, V.; Lyutskanova, R. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 745-748(Sep-Oct 1976).

The low-temperature behavior of diesel fuels is one of their most important service characteristics; this behavior is governed by the hydrocarbon composition. A predominance of the higher normal paraffinic hydrocarbons, as well as naphthenes and aromatics with long unbranched side chains, will result in poor low-temperature properties for the diesel fuels. This paper presents results of a study which was carried out in order to improve these properties by hydrocracking of higher normal paraffins in presence of fluorine-containing catalyst. The original catalyst used in this work was commercial cobalt/molybdenum hydrodesulfurization catalyst; fluorine was introduced into this catalyst by treatment with 14 N HF at 10°C, after which the mixture was held 48 h at 0°C and dried 4 h at 105°C. The feedstock was a 240-350°C gas oil cut. The catalytic action of the modified catalyst was evaluated on the basis of the change in distillation curve, hydrocarbon composition, and low-temperature properties of the liquid products. Extensive experimental data are tabulated and discussed in terms of practical recommendations. 7 refs.

7984 Purification of liquid paraffins by hydrogenation over 3076-A catalyst. Zelentsov, Y.N.; Bocharov, A.P.; Shvachev, V.G.; Orechkin, D.B. (Angarsk Petrochem Comb, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 748-751(Sep-Oct 1976).

In the preparation of liquid paraffins as a raw material for the petrochemical industry, primary attention has been given to the treatment of these materials to remove aromatic hydrocarbons. Current quality requirements for the paraffins call for a residual content of aromatic hydrocarbons not greater than 0.5% by weight. A high content of normal paraffinic hydrocarbons is another important quality requirement. This situation is responsible for the inclusion of a sulfuric acid treating stage in the liquid paraffin production facilities in USSR refineries. Another method of dearomatization is selective catalytic hydrogenation. From all catalysts used, the most active and selective with respect to the hydrogenation of aromatic hydrocarbons is the 3076 catalyst, containing WS$sub 2$. However this catalyst was inadequate in mechanical stability, breaking down during operation. In the reported experiments, tests have been run on a 3076-A catalyst, prepared with an aluminum oxide support; this catalyst has a better mechanical stability, with identical initial mechanical strength. The characteristics of this catalyst are compared with those of the conventional 3076 catalyst in table 1. Experimental data are presented which show that the 3076-A catalyst can be recommended for the hydrogenation treatment of liquid paraffins as applicable to a commercial G-24 unit operating at pressures no greater than 40 kgf/cm$sup 2$. 2 refs.

7985 Modifying effect of calcium alkylphenolate (AFK) additive in deoiling petrolatum. Kazakova, L.P.; Gundyrev, A.A.; Litvinova, N.A.; Vasilenko, O.V. (Gubkin Moscow Inst of the Petrochem and Gas Ind, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 758-762(Sep-Oct 1976).

In recent years, considerable attention has been given to the use of pour-point depressant additives as modifiers of the structure of solid hydrocarbons in dewaxing residual raffinates and in deoiling petrolatums. Additives of various structures have been examined for use as modifiers of the structure of the solid hydrocarbons in petrolatum with the aim of speeding up the deoiling process. The results from these studies showed that the additives calcium alkylphenolate (AFK), AzNII [wax-alkylated naphthalene], and polymethacrylate (PMA$sub d$) can be used for this purpose. The introduction of one of these additives, after heat treatment of the petrolatum solution, increased the filtration rate by a factor of 1.5-2, at the same time increasing the yield of high-melting microcrystalline wax. The aim of the present work included an investigation of the distribution of additive between the solid and liquid phases when carrying out a deoiling process. Experimental results are presented and discussed. 3 refs.

7986 Influence of water consumption on degree of desalting of crude oil. Idrisova, T.S.; Abyzgil'din, Y.M.; Telyashev, G.G.; Zagidullin, R.M.; Pokhitun, L.E. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 762-765(Sep-Oct 1976).

One of the primary factors affecting the operating efficiency of an ELOU [electric desalting unit] is the quantity of fresh water fed to the washing operation and how vigorously it is mixed with the crude oil. At the Novo-Ufa Petroleum Refinery, a study has been made on the influence of wash-water consumption on the crude oil desalting process. The characteristics of the crude oil used in this work are listed. The operating conditions of the units are shown. Extensive experimental data are presented which show that with any of three types of crude oil tested, an increase in wash water consumption gives an increased dewatering and desalting effect. The major quantity of brine water and salts is removed from the crude oil in Stage 1; the use of larger amounts of wash water gives better results. For the mixed crudes and the Bondyug crude, the use of 6% water [in Stage II] is sufficient to achieve the maximum removal of water and salts, i.e., up to 70-85% removal. In washing the Arlan crude [in Stage II], an increase in water feed from 5.5 to 8.7% gives a considerable improvement in the quality of the treated oil. The optimal removal of salts is achieved with a water consumption of 10%.

7987 Optimization of operating regime of absorption section in gas separation units. Gorechenkov, V.G.; Kuznechikov, V.A. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 775-780(Sep-Oct 1976).

In this article, the authors examine the question of optimizing the process conditions for the absorption section of a gas separation unit in a refinery or gas processing plant. The importance of this work stems from the fact that the operation of this process involves major energy costs. A simplified diagram of the absorption section is shown. Mathematical equations are presented which have been derived for process optimization along with relevant algorithm. 4 refs.

7988 Principles of automatic control of sharp fractional distillation process. Mazina, S.G.; Alekseev, Y.A. (All-Union Sci-Res Inst of petrochem Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 780-785(Sep-Oct 1976).

Quite a number of variants are being used commercially in schemes for automatic control of the distillation process. Most of these schemes have been constructed on a purely empirical basis. However, it is clear that control schemes should reflect the physical relationships involved in the process. In this paper the authors have set forth certain general premises that have been used as the basis for developing an automatic control system for the process of sharp fractional distillation. A discussion of process parameters which should be monitored is followed by a description of an automatic operating control system for distillation tower. Automatic control system for distillation tower separating a heteroazeotropic mixture is

also included. The principles examined in the reported investigation have been applied in developing automatic control systems for distillation towers, with due regard for the specific properties of individual vessels, and have been introduced in a number of units at various Russian petroleum refineries. 4 refs.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 7976, 7977, 7981, 7983, 7984, 8014, 8015, 8016, 8018, 8019, 8020, 8021, 8022, 8031

7989 (NP—22650) **Potential for a petrochemical industry in Utah.** (Utah Engineering Experiment Station, Salt Lake City (USA)). Dec 1975. 10p. Engineering Station, Salt Lake City.

This study assesses the U. S. petrochemical industry, Utah's raw and non-raw materials as plant site factors, alternative petrochemical products for a Utah plant, and petrochemical plant possibilities for the state. Possible impact of such a plant on Utah's economy is considered briefly. (DLC)

7990 **Effects of transformation degree of petroleum-based hydrocarbons in the first step of oxidation and their composition on the yield of dicarboxylic acids.** Szalajko, U.; Fiszer, S. (Politech Slaska, Gliwice, Pol). *Przem. Chem.;* **56**: No. 1, 20-23(Jan 1977). (In Polish).

Based on the results of attempts at two-step synthesis of dicarboxylic acids by oxidating hydrocarbon petroleum raw-materials, there has been established (using the methods of statistical analysis) a linear correlation between yields of acids and the degree of transformation of hydrocarbon raw materials in its first step of oxidation, as well as an influence of the chemical composition of raw materials on the yield of the acids. 20 refs.

7991 **Principles of accounting for the main technological factors in constructing models of technico-economic optimization of utilization of petrochemical units.** Dokuchaev, E.S.; Bryugenman, A.F.; Tishchenko, V.E.; Orel, I.S. (Ufa Pet Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 101-106(1977). (In Russian).

A method of integral evaluation of particular technological regularities in petrochemical industry from the point of view of the universal economic criterion--the profitability level of an enterprise--is set forth. A general structure of the economico-mathematical model is given, within the framework of which analytical representation of the effect of technological factors on the costs of production and profitability is realized. It may also be utilized for finding such a combination of the technological and organizational parameters of the process which would help to assure either minimal costs of production or a maximum profitability level.

7992 **Determination of fractional composition of petroleum products by chromatographic simulated distillation.** Gol'dshtein, K.R.; Frenkel, B.A.; Lerman, A.G.; Lipavskii, V.N.; Zhuravleva, M.A.; Vasin, L.S. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 674-678(Sep-Oct 1976).

One of the means for speeding up the development of petroleum refining and petrochemical processes and the testing of catalysts for these processes is miniaturization of the testing units. For effective utilization of these units, the fractional composition of the feedstock and products must be determined. As only microquantities of the substances are available for analysis, conventional distillation methods cannot meet this need. A new analytical method for determining the fractional composition of complex mixtures is simulated distillation, which will give within 1-2 h the required information on the distribution of the boiling point by fractions. The simulated distillation method consists essentially of the introduction of the test mixture into a low-efficiency chromatographic column with a nonpolar liquid phase, where the components are separated by boiling point with linear programming of the temperature of the column thermostat. Details of the system and results of its experimental applications are given. The studies reported have resulted in the development of a procedure and a program for calculating the results of simulated distillation of various petroleum products including naphthas (gasolines). 7 refs.

7993 **Oxidation of residuum in aqueous sodium carbonate medium and use of oxidized product to improve adhesion properties of asphalt.** Antonishin, V.I.; Tushnitskii, O.P.; Gumenetskii, V.V. (L'vov Polytech Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 706-711(Sep-Oct 1976).

The quality of paving asphalts can be improved by the use of adhesion additives. The oxidation of a residual stock with atmospheric oxygen in an aqueous sodium carbonate (soda) medium at elevated temperature and pressure has yielded a mixture of organic oxygen-containing compounds with surface-active properties, suitable for use as an asphalt adhesion addition. The residuum was oxidized in a large laboratory unit in a reactor vessel with vigorous mixing by recirculation. In the reported investigation, the residuum oxidation process was studied in a mathematically designed experiment. A Box-Wilson central composite design was used. Experimental data are presented and analyzed. It is demonstrated that the greatest influence on the residuum oxidation process (within the region of factor variation under examination) was that of temperature; the pressure and the length of the oxidation period had somewhat less influence, and the residuum/soda ratio had almost no influence on the process. 6 refs.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 7991, 8007, 8559

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 7879, 7881

7994 (PB—268492) **Chemically active fluid-bed process for sulphur removal during gasification of heavy fuel oil - third phase. Report on phase 3, Jul 1973—Sep 1975.** Craig, J.W.T.; Johnes, G.L.; Kowszun, Z.; Lyon, D.; Malkin, L.S. (Esso Research Centre, Abingdon (UK)). Sep 1976. Contract EPA-68-02-1359. 607p. NTIS PC A99/MF A01.

The report describes the third phase of studies on the CAFB process for desulfurization/gasification of heavy fuel oil in a bed of hot lime. Major conclusions relating to process performance and operability are: (1) water, either in the fuel or in the fluidizing air, has a strongly adverse effect on desulfurizing efficiency; (2) good desulfurizing efficiencies are obtainable at very low stone replacement rates; (3) process performance can be expressed as a statistically derived equation; (4) a burnback burner is feasible for coke removal; (5) SO2/stone disposal by sulfation is not feasible, but deadburning looks promising; and (6) most trace elements are retained in the bed. Among tasks included in this phase were: (1) batch reactor evaluation of three limestones and gasification/desulfurization of a vacuum bottoms fuel; (2) two pilot plant runs using deep beds and demonstrating improved operational techniques; (3) development of a statistical method for analyzing results of the two pilot plant test runs and reconciling them with earlier results; (4) sulfation of bed material as a means of disposing of SO2 and spent lime; (5) deadburning as a means of treating spent bed material prior to disposal; (6) retention of the bed material of a wide range of trace elements contained in the fuel; and (7) demonstration of a burn-back burner to overcome coke lay-down in cyclone inlets.

7995 (PB—268524) **Thermodynamic analysis of an oil reclamation process.** Jhawar, K.R.; Grossmann, E.D.; Brown, H.L.; Hamel, B.B. (Drexel Univ., Philadelphia, Pa. (USA). Energy Sources and Systems Inst.). Jan 1977. 200p. (EIR—77/1). NTIS PC A09/MF A01.

This study provides quantitative methodology for characterizing the energy utilization efficiency of waste oil reclamation processes. A simple, reasonably accurate approach was taken to predict the thermodynamic availability, enthalpy, and entropy of petroleum fractions, water, and stack gas. The NORCO process was used as a case study. The thermodynamic analysis is based on an availability balance including a lost work term associated with each unit of equipment. From the availability analysis, the extent of irreversibility associated with each equipment in the process is determined. The lost work is then summed over the total system, to yield the total process lost work. Efficiency based on the ideal work of the process and the total process lost work is defined as a means to measure the energy utilization efficiency of the process. The sample process was then modified to take into account possible heat integration by use of series of co-current as well as counter-current exchangers. The resulting overall thermodynamic efficiency when co-current exchangers were used is calculated to be 3.23% and when counter-current exchangers were used the efficiency rises to 3.73%, thus demonstrating the value of heat integration.

7996 **Oil and waste water reception facility and process.** Propp, C.F. US Patent 4,048,070. 13 Sep 1977. Filed date 3 Jun 1976. 8p.

Decantation tanks receive an oil-water mixture from a holding tank. These decantation tanks are set at varying elevations and are arranged to operate in series to drain off oil that has separated out. These tanks may have heat producing elements associated therewith to increase the efficiency of oil separation, and chemicals may be employed in these tanks also to increase such efficiency if necessary. Separator tanks are also provided in the system and receive oil-water mixture from the bottom of the decantation tanks for further separation of oil from the water. These separator tanks have a skimming apparatus therein and also have a pair of baffles under which the water must travel to accomplish further separation of the oil. The separator tanks have a cross partition, and water in a main portion of the tank flows over such partition to a rear compart-

ment from where it is directed to an open top inspection tank and filtered. The pH of the effluent may be altered at this point if necessary. The water upon discharge from the inspection tank is substantially oil free and is then directed into a waste water pond for disposal. The system employs an extensive manifold arrangement between the various elements for by-passing, recirculation, etc. 5 claims, 4 drawing figures.

7997 Purifying drilling wastewater from mechanical impurities on a hydrocyclone installation. Mustafaev, A.M.; Gutman, B.M.; Karaev, M.A.; Ershov, V.P. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 37-39(1977). (In Russian).

Problems of purification of drilling wastewater in order to ensure its multiple use and prevent pollution of a sea area are considered. The possibility of using hydrocyclones for removing mechanical impurities from wastewater is studied. As a result of experiments, a method is worked out and optimum parameters of purification on a hydrocyclone plant with the efficiency of 90-93% by means of recirculation are determined.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 7997, 8997, 9096, 9101, 9104, 9107

7998 (PB—267266) **Oil spill and oil pollution reports, August 1976-October 1976. Quarterly report.** Melvin, P.; Ehrenspect, H.; Nordin, P. (California Univ., Santa Barbara (USA). Marine Science Inst.). Feb 1977. 321p. NTIS PC A14/MF A01.

The August 1976 - October 1976 Oil Spill and Oil Pollution Reports is the ninth quarterly compilation of oil spill events and oil pollution report summaries. Presented in the report are: (a) summaries of oil spill events; (b) summaries and bibliographic literature citations; (c) summaries of current research projects; and (d) patent summaries. This report is submitted in partial fulfillment of EPA Grant No. R-803392 by the Marine Science Institute, University of California, Santa Barbara, under the sponsorship of the Environmental Protection Agency.

7999 (PB—267632) **Evaluation of pollution potential of proposed Hampton Roads Energy Company Refinery, Portsmouth, Virginia.** Norton, L.E.; Kuedtke, K. (Pacific Environmental Services, Inc., Santa Monica, Calif. (USA)). Nov 1976. Contract EPA-68-02-1378. 245p. NTIS PC A11/MF A01.

This report is an evaluation of air pollution potential associated with the proposed Hampton Roads Energy Company Petroleum Refinery to be located at Portsmouth, Virginia, and was prepared for the U.S. Environmental Protection Agency. Emission estimates in this report reflect the use of best available control technology for both fugitive and point sources. The report analyzes particulate, sulfur oxides, nitrogen oxides, and hydrocarbon emissions. The estimate of emissions from the refinery complex includes the unloading of crude tankers, and the loading of product barges at the marine facilities. Calculations by the refinery contractor (Foster Wheeler Energy Corporation) are reviewed.

8000 (PB—268248) **Oil spill and oil pollution reports November 1976 - January 1977. Quarterly report.** Melvin, P.; Ehrenspeck, H.; Nordin, P. (California Univ., Santa Barbara (USA). Marine Science Inst.). Apr 1977. 306p. NTIS PC A14/MF A01.

Subjects covered include all aspects of aquatic and terrestrial oil pollution. Items in Section I are categorized by seven major subdivisions which are divided into thirty-two specific subject categories. These are presented in the Table of Contents. Patents and patent applications are announced under appropriate subject categories. Subject and author indexes for entries in Section I are provided at the end of the report. A list of the periodicals reviewed in preparing this series appears in the Appendix. Section II presents titles of active or recently completed oil pollution research projects, summaries of project objectives, and current status information and/or resulting publications provided upon request by the principal investigators or performing organization. Section III, Current Oil-Related Conferences, contains descriptive information on recently held and upcoming conferences relevant to any aspects of oil pollution.

8001 (PB—268515) **Major oil spills from tankers and barges and other vessels in U.S. waters/analysis of recent trends and patterns. Final report, 1976—1977.** Young, G.K.; Warner, L.S.; Jettmar, R.U. (GKY and Associates, Alexandria, Va. (USA)). 1 May 1977. Contract EQ7AD239. 30p. NTIS PC A03/MF A01.

An investigation of oil spills during the winter 1976-1977 and comparison with spills since 1969.

8002 (PB—269244) **Alaska OCS socioeconomic studies program, literature survey.** (Peat, Marwick, Mitchell and Co., Anchorage, Alaska (USA); Dames and Moore, Anchorage, Alaska (USA)). Apr 1977. Contract DI-AA550-CT6-61. 495p. NTIS PC A21/MF A01.

The Literature Survey is the second of six reports comprising the first year of the Alaska OCS Socioeconomic Studies Program, and establishes the basic information context for the project's other components. The literature reviewed has a broad relevance to OCS development in Alaska and four petroleum development regions: the Beaufort Sea Region; Bering Sea Region; Southwest Region; and the Gulf of Alaska Region. Sixteen chapters discuss the most relevant literature, current research and data gaps. Each subject chapter includes a bibliography listing cited literature. A master bibliography of the 1200 items surveyed, and an index to that bibliography by subject, key word, and OCS region is also included.

8003 Oil spill cleanup system. Ayers, R.R. (to Shell Oil Co.). US Patent 4,049,554. 20 Sep 1977. Filed date 15 Mar 1976. 10p.

Skimmer for removing oil from the surface of a body of water is articulated from front to rear to be wave conformable and/or has a quiescent collection zone formed by bottom and/or forward baffles. The following are described: flexible skimming head for use with or independently of the above skimmer composed of a foraminous sheet having an integral chevron flow pattern on its upper surface; floating skimming head for use similar to the preceeding head with a central, axially vertically movable cone or other configuration forming a suction mouth; boom for use with or independently of the above skimmer which is composed of converging double booms; storage capacity for oil collected by the above skimmer or otherwise composed of onboard and/or offboard membranes. 5 claims, 14 drawing figures.

8004 Water polishing means for removing oil and other flotsam from water. Stebbins, G.B.; Stebbins, J.F. US Patent 4,049,553. 20 Sep 1977. Filed date 12 Apr 1976. 10p.

An apparatus is described for removing oil and other flotsam from water, including an elongate tank with an inlet at the upstream end for introducing a fluid and flotsam mixture into the tank to provide a mean fluid level in the tank. A plurality of longitudinally spaced, vertical dams extend transversely across the tank dividing it into longitudinally spaced zones, each of the dams having an upper edge spaced below the mean fluid level in the tank. A vertical weir is provided in each zone extending across the tank so as to divide the zone into an upstream section and a downstream section. Each of the weirs has an upper portion which extends above the mean fluid level and a lower edge spaced above the bottom wall of the tank. The weirs are preferably angularly positioned relative to the longitudinal axis of the tank so as to converge with the side wall of the tank at an acute angle to provide a collecting corner for receiving flotsam. Skimming means are provided at various of the upstream collecting corners to remove the flotsam which collects therein. An open-ended pipe is provided at one or more of the downstream collecting corners, the open end of the pipe being positioned beneath the fluid surface, and pump means are provided to cause a mixture of fluid, flotsam and air to be drawn into the open end of the pipe and to be transported to one or more of the upstream zones and to be dispersed therein for further downstream flow. 6 claims, 5 drawing figures.

8005 Responses of Arctic marine benthic crustaceans to sediments contaminated with crude oil. Percy, J.A. (Arctic Biological Station, Ste. Anne de Bellevue, Can.). *Environ. Pollut. (London);* **13**: No. 1, 1-10(May 1977).

The responses of several arctic marine benthic crustaceans to sediments experimentally contaminated with crude oils have been examined. The amphipod Onisimus affinis overwhelmingly selected clean rather than oil-contaminated sediments. The response was most pronounced at low oil concentrations and the ability to discriminate was abolished at the highest concentrations tested. Weathering of the oiled sediment for 1 week reduced the avoidance response. Another amphipod and two isopod species tested did not discriminate consistently between oiled and clean sediments. Potential ecological consequences of these behavioral responses are discussed.

8006 Data on the ecology of a literal marine zone receiving wastes from a petroleum refinery. Le Petit, J.; N'Guyen, M.H.; Tagger, S. (Univ., Aix-Marseille). *Environ. Pollut. (London);* **13**: No. 1, 41-56(May 1977). (In French).

The effects of a petroleum refinery effluent overflow in the sea on the physical and chemical characteristics, phytoplanktonic production and bacterial population have been studied. The high temperature of the water effluent involves thermic variations in the overflow area, occasionally producing an environment very poor in oxygen. Variable but sometimes very high $P—PO_4$ concentrations induce serious disturbances in the $N—NO_3/P—PO_4$ ratio. An $N—NO_3$ reduction, probably of bacterial origin, increases the lack of balance of this ratio. Chlorophyll a concentrations measured close to the effluent area are approximately equal to those of offshore waters but the $N—NO_3/P—PO_4$ ratio lead us to assume that phytoplanktonic species may be different. Bacteria utilizing a gas-oil as the sole carbon source represent 10% of heterotrophic bacteria in the efflu-

ent area and 4% in an area not directly polluted by hydrocarbons. Physical and chemical conditions in the effluent area are not favorable to the phytoplanktonic population equilibrium, but seem to be so for a hydrocarbon degradation by bacteria.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 8596, 8597

8007 (PB—268388) **How Federal regulations are putting independent oilmen out of business. Final report.** Johnson, W.A. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). 19 Sep 1975. 9p. NTIS PC A02/MF A01.

This report details how Federal price regulations on oil, and, in particular, the government's entitlements program, have made it impossible for an independent gasoline marketer to remain in business. It is meant to provide a case study of the failure of a regulation to achieve its intended effect.

8008 (PB—268398) **The Naval Petroleum Reserves. Final report.** (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). 27 Jan 1975. 20p. NTIS PC A02/MF A01.

This report examines the controversy over development of U.S. Naval Petroleum Reserves. It traces the history and purpose of these reserves, and discusses the various arguments for and against their development.

8009 (PB—268400) **Competition in the oil industry. Final report.** Johnson, W.A.; Messick, R.E.; Van Vactor, S.; Wyant, F.R. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). Dec 1975. 133p. NTIS PC A07/MF A01.

This report explores a number of issues concerned with the competitiveness or lack of competitiveness of the U.S. oil industry. Among the issues considered are concentration and changes in concentration in various segments of the industry, market shares in the retailing of gasoline, vertical and horizontal integration, joint ventures, barriers to entry, interlocking directorates, exchange and processing agreements, and profit rates.

TRANSPORT, PIPELINES, AND HANDLING

8010 **Gathering line leak detection system tester.** Morris, D.A.; Flournoy, N.E.; Langley, T.W. (to Texaco Inc.). US Patent 4,043,180. 23 Aug 1977. Filed date 10 Dec 1975. 8p.

A system employing a plurality of electronic oscillators for generating test signals at spaced locations remote from a selection point is claimed. The oscillators are coupled to a gathering line for petroleum products, each being located adjacent to an acoustic detector coupled to the line for signaling the presence of a leak within its range. A digital selector which manually generates a given number of pulses is located at the selection point. There is a binary counter at each oscillator to receive the pulses. And, there is also a binary encoder at each oscillator to determine which one will be energized, depending upon the number of pulses generated by the selector. 6 claims, 2 figures.

8011 **Oil pipeline and loading pumps.** McKenna, P. (Mather and Platt Ltd, Manchester, Engl). *S. Afr. Mech. Eng.;* **27**: No. 4, 125-129(Apr 1977).

The paper describes two oil pipeline pumping installations of very closely similar duty, the first installed in the immediate post-war period (1950), and the second of recent design (1970), which illustrate the extent of development in this field during this period. A detailed description is given of the construction and metallurgy of the pumps used with comparisons of size, layout and performance. Current design philosophy is discussed together with its relationship to possible future developments in Southern Africa.

8012 **Utilization of simulation modeling in investigating the process of operation of oil field fleet.** Vigdorov, N.L. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 85-89(1977). (In Russian).

Simulation modeling as a method of investigating the process of operation of self-propelled and crane ships of the oil field fleet is considered. In a formalized form, the process is represented as a model of functioning of a mass service system consisting of a number of blocks. The model retains the logic of the structure of the process, the sequence of occurrences in time, and the character and composition of information about the condition of the system and its elements. Results of investigation of two variants of a centralized and a deneutralized structure of organization of operations are presented.

PROPERTIES

REFER ALSO TO CITATION(S) 7859, 7981, 7992, 7993

8013 **Experimental determination of the thermal conductivity and p-v-t relationships for liquid chlorobenzene and isopropyl-benzene.** Guseinov, K.D.; Mirzoev, B.M. (V.I. Lenin State Pedagog Inst, Azerb SSR). *Int. Chem. Eng.;* **17**: No. 1, 109-111(Jan 1977).

An experimental determination was made of the thermal conductivity and density of liquid chlorobenzene and isopropylbenzene as functions of the temperature and pressure over the ranges of 285-602 K and 1-500 bars, respectively. A correlation was also made of the excess thermal conductivity as a function of the density. 7 refs.

8014 **Investigation of depressor properties of isoprenoid hydrocarbons.** Vyskrebentsev, V.P.; Petrova, A.A. (Groznyi Pet Inst im. M.D. Millionshchikov, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 53-56(1977). (In Russian).

The effect of isoprenoid hydrocarbons on the temperature of the beginning of crystallization and structural solidification of paraffin solutions is studied. It is shown that squalane and phytane cannot be recommended as depressors.

8015 **True gas contents in bubbling processes.** Korotaev, Y.P.; Semenov, N.I.; Koldasov, T. (Moscow Inst of Petrochem and Gaz Ind im. I.M. Gubkin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 59-64(1977). (In Russian).

On the basis of experiments involving air bubbling through a column of glycerine solution in water of different concentration, experimental data are presented on the true gas content. The latter is presented in the form of its dependence on the Froude number and reduced density and viscosity of components. The Froude number was measured from zero to the value at which an almost complete ejection of the liquid took place.

8016 **Experimenal investigation of specific volumes of benzene in the critical region and determination of the critical specific volume.** Akhundov, T.S.; Abdullaev, F.G. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 73-77(1977). (In Russian).

Results of precision investigations of the P-V-T relations of benzene in the vicinity of the critical point are presented. Measurements have been carried out on an experimental setup operating according to the constant-volume piezometer method, both as regards isotherms and isochores. It is found that the critical and close to it isochores on the P,T-diagram have a substantial curvature. This fact was taken into account in utilizing the Planck-Gibbs phenomenological rule to determine the v$sub cr$ of benzene. As a result of processing, the value of the critical specific volume has been found v$sub cr$=3,320^{+}-0.040 cm^{3}/g. Likewise, it has been found that T$sub cr$=562.60 K and P$sub cr$=49.429 bar. 14 refs.

8017 **Viscosity of fuel emulsions and suspensions.** Kofanov, V.I. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 1, 109-113(1977). (In Russian).

The effect of dispersed phase particles in the form of an ellipsoid on flow hydrodynamics is considered. A relation is obtained determining the viscosity coefficient of suspensions and emulsions which takes into account the form and orientation of the dispersed phase. The calculated and experimental data are compared.

8018 **Structure of sulfur compounds in medium-viscosity oils from Ust'-Balyk crude.** Kucheryavaya, N.N.; Rozanova, Z.I.; Siryuk, A.G.; Sidlyaronok, F.G.; Brodskii, E.S. (All-Union Sci-Res Inst for Pet Process, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 690-694(Sep-Oct 1976).

The lube oils obtained from Siberian crudes have good viscosity-temperature properties and contain considerable amounts of sulfur (around 1% or higher), whereas the oils from Volga-Ural crudes with the same V.I. contain no more than 0.6% sulfur. The higher contents of sulfur in the oils from the Siberian crudes are related to the specific structural characteristics of the sulfur compounds present in the lube oil cuts from the crudes, such that the sulfur compounds are relatively less soluble in phenol during the lube manufacturing process. In order to make a rational selection of efficient additives for the oils from Siberian crudes, it is necessary to know the structures of not only the hydrocarbons, but also of the sulfur compounds. In this paper the authors present results obtained in a study of the sulfur compounds recovered from a medium-viscosity oil from Ust'-Balyk crude. The characteristics of this lube are given. The data presented on the composition and structure of sulfides show that the sulfides present in an oil obtained by phenol treatment of a medium-viscosity distillate from Ust'-Balyk crude consist of 86% saturated compounds. Sulfides of such a structure are valuable high-V.I. components of lube oils with good antioxidant properties. 4 refs.

8019 Kinetics of mechanical breakdown of copolymers of isobutylene with o- and p-methylstyrene. Sadykhov, Z.A.; Akhmedov, R.Y. (Azerb State Univ, Az SSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 695-697(Sep-Oct 1976).

The timewise change in kinematic viscosity of polymer-thickened lube oils is the simplest and most effective kinetic method for rating the mechanical stability of polymeric thickeners. The rate of mechanical breakdown of polyisobutylene or a copolymer of isobutylene with styrene is related to the polymer concentration in the oil and the polymer molecular weight. The present article is devoted to an investigation of the kinetics of mechanical breakdown of copolymers of isobutylene with o- and p-methylstyrene in solutions in a low-viscosity lube distillate (spindle oil). The mechanical stability of the copolymers was evaluated in an SMD-14 unit using an injection spray method based on spraying oil solutions through nozzles and recirculating the oils in a specially designed system. Experimental data are presented which show that the rate of mechanical breakdown of copolymers in compounded oils is proportional to the square of the molecular weight, whence it follows that the mechanical breakdown of the copolymers occurs in accordance with a "random" law. It has been shown that copolymers of isobutylene with o- and p-methylstyrene are better than the polyisobutylene with respect to mechanical stability in compounded oil solutions. 3 refs.

8020 Influence of impurities on tar formation and thermal stability of diethylene glycol. Barkov, I.I.; Sharonov, K.G.; Rozhkov, A.M.; Izmailov, V.D.; Lazarev, A.V. (Syzran' Pet Refin, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 697-699(Sep-Oct 1976).

In this article the authors present results from studies aimed at improving the service properties of diethylene glycol (DEG) used as an extractant in units for the extraction of aromatic compounds. In experiments, effect of various additives on the thermal stability and drop in pH of the medium was investigated. The results obtained show that the maximum drop in pH is observed in the first 20 h of thermostating and is most pronounced when the hydroperoxide or formaldehyde is used as an additive. The dependence of DEG tar formation on various additives when thermostated at 150$degree$C is shown in table 1. The maximum quantity of tarry substances is formed upon the addition of tert-butyl hydroperoxide or formaldehyde. The addition of acetone has only a very slight effect on pH change and on tar formation. The studies that have been conducted have made it possible to identify certain light impurities in DEG. It has been established that some of these impurities have an adverse effect on tar formation and also contribute to a drop in pH of the recycling DEG. The need for treating DEG to remove the light impurities has been demonstrated. 8 refs.

8021 Investigation of oxidation stability of certain mineral oils by means of infrared spectroscopy. Egorova, K.A.; Zuseva, B.S.; Filimontseva, V.A.; Zeitseva, A.N. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 790-793(Sep-Oct 1976).

Mineral oils produced from different crudes by treating at various levels of severity manifest different degrees of oxidation resistance. Infrared spectroscopy may be used in obtaining comparative ratings of oil oxidizability, since it permits the investigator to follow the kinetics of end-product accumulation in the bulk oil during oxidation. As an index of the oxidation stability, a nominal value of the rate of accumulation of oxidation products may be used, as characterized by the slope of the kinetic curve. In the reported experiments, the oxidation was performed on DS-11 lube oil base stocks produced in various refineries. Compensation IR spectra were recorded for oxidized oil samples taken after each hour of oxidation. The kinetics curves of oxidation for various oils tested are presented and evaluated. In table 1 the authors compared the service property indices with IR spectroscopic data on the rate of accumulation of final oxidation products. It is noted, the lower rates of accumulation of final oxidation products in the bulk oil correspond to smaller amounts of varnish as determined at 250$degree$C. It has been established that, when DS-11 oils from various crudes are oxidized in the kinetic regime at 175$degree$C, identical quantities of final oxidation products are formed (acids, ethers, and esters), but the rates of formation of these products are different for the different oils, correlating with the quantity of sulfur (a lower sulfur content corresponds to a lower oxidation rate). 11 refs.

8022 Rapid method of determination of asphaltene content in petroleum crudes and products. Mirsayapova, L.I.; Knyazeva, T.N. *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 805-807(Sep-Oct 1976).

The methods presently used in determining asphaltenes in petroleum crudes and products are quite laborious and time-consuming; hence, the use of these methods in routine production analysis has been quite limited. For a faster quantitative determination of the content of asphaltenes in crude oil, it is possible to use a known photocolorimetric method based on determination of the light absorption of the crude K$sub ab$ according to the optical density of a solution of the crude. An analytical procedure is described which has been developed for the determination of asphaltene content in petroleum crudes and products. It is pointed out that this method because of its simplicity, rapidity, and economy in reagent consumption, will find wide application in certain repetitive rapid analyses of petroleum crudes and products.

8023 Procedure for determination of vanadium in crude oils by ion exchange method. Myagkova, G.M.; Amelina, Z.S.; Amelin, A.N. (Tyumen' Ind Inst, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 807-808(Sep-Oct 1976).

Metallic impurities present in petroleum feedstocks are the source of gas and coke formation, leading to rapid deactivation of catalysts and a drop in gasoline yield. It has been established that many metals, including vanadium, have a poisoning effect on catalysts. Hence, the determination of trace elements in petroleum crudes and products is of considerable interest. The analytical method is described in which ion exchange resins are used in extracting vanadium compounds from crude oils. Since the sulfonate cation exchange resins are inadequate in selectivity, the authors have investigated the use of highly selective complex-forming ion-exchange resins for the concentration and subsequent determination of vanadium. Functional groups for these resins are α-aminomethylphosphinic acid (AMP) and $alpha$-aminomethylphosphonic acid (ADP) groups. For comparison, the authors investigated SF-5 resin, which contains only phosphonic acid groups, and SFM resin, with hydroxymethylphosphinic acid groups. Procedural details are given. 3 refs.

8024 Establishment of test methods for determination of total nitrogen in fuel oils. (0100). *Bull. Jpn. Pet. Inst.;* **17**: No. 1, 123-131(Apr 1975).

The Japan Petroleum Institute has investigated means for determination of total nitrogen in fuel oils. This report describes the activity of the subcommittee organized for the establishment of testing methods for nitrogen content in petroleum products and for preparation of a draft for JIS method. The committee has established four methods, macro-Kjeldahl, micro-Kjeldahl, automated Dumas, and microcoulometric titrating which are applicable to the samples containing more than 0.01% N. In addition, a unique technique for coulometrical determination of total nitrogen in many residual oils is devised. 5 refs.

8025 Determination of aromatic hydrocarbons in petroleum fractions by infra-red spectroscopy. Fallah, A.; Badakhshan, A.; Moghadam, P.; Sayed-Ahmadi, A. (National Iranian Oil Co., Teheran). pp 254-262 of In Proceedings of the fourth symposium on the development of petroleum resources of Asia and the Far East. New York; United Nations (1973).

From 4. symposium on the development of petroleum resources of Asia and the Far East; Canberra, Australia (27 Oct 1969).

See CONF-691079—P2.

Development of techniques for analysis of gasoline and naptha fractions obtained from paraffinic and mixed-base crude oils is reported. Infra-red spectrophotometry has been applied successfully to qualitative and quantitative analysis of aromatics contained in light petroleum fractions and has proved the most convenient and accurate of presently available techniques for this purpose. Although the paper deals with two relatively simple cases in which there are only a limited number of aromatic hydrocarbons in the samples, theoretically the method can be applied to the analysis of more complex hydrocarbon mixtures. The only practical difficulty is that the number of linear equations to be solved simultaneously increases in proportion to the number of components present in the analytical sample. Therefore, if the number of components is large, the solution of these equations becomes tedious and time-consuming. If as in the two cases studied, however, an electronic computer is available, even a highly complex set of linear equations can be easily solved in not more than a few minutes. Theoretically, the only limitation in the application of this method might occur when the characteristic bands of the components in the analytical sample are small or superimpose one another.

8026 Progress in tribology with special reference to Iran and National Iranian Oil Company's Research Centre. Fallah, A.; Badakhshan, A.; Behbahani, F. (National Iranian Oil Co., Teheran). pp 262-270 of In Proceedings of the fourth symposium on the development of petroleum resources of Asia and the Far East. New York; United Nations (1973).

From 4. symposium on the development of petroleum resources of Asia and the Far East; Canberra, Australia (27 Oct 1969).

See CONF-691079—P2.

The development and use of petroleum lubricants are examined. Tribology general considerations are discussed along with lubricant requirements, performance of lubricants, oxidation resistance, detergent and dispersant quality, corrosion resistance, pressure behavior, and other performance characteristics. The status of tribology in Iran is summarized. (JRD)

NATURAL GAS

RESERVES

REFER ALSO TO CITATION(S) 7927

8027 Determination of gas reserves of a gas and condensate bed in the absence of data on stratal condensate losses. Zakirov, S.N.; Kondrat, R.M. (Moscow Inst of Petrochem and Gaz Ind im. I.M. Gubkin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 48-52(1977). (In Russian).

A method of determination of gas reserves of a gas and condensate bed is proposed using production data about stratal pressure, overall output of gas and condensate and results of laboratory investigations of the gas and condensate mixture. Results of utilization of the proposed method for conditions of the Vuktyl gas and condensate deposit in the Komi ASSR are presented.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 7931, 7932

8028 Neutron well logging technique for gas detection. Bateman, R.M; Clavier, C.M. (to Schlumberger Tech. Corp.). US Patent 4,047,027. 6 Sep 1977. Filed date 29 Mar 1976. 16p.

In accordance with an illustrative embodiment of the present invention, a technique is disclosed for determining a characteristic of an earth formation by irradiating the formation with a source of neutrons and measuring the resulting neutron population at two different spacings from the source. Each neutron population measurement is converted into a signal which is related to the formation porosity corrected for environmental effects. The two converted signals are then compared with the porosity derived from the ratio of the two neutron population measurements in order to obtain an indication of the presence of gas in the formation. 19 claims, 11 figures.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 7952, 7960, 7975, 7987

8029 (PB—268613) Lake Erie offshore drilling. (New York State Senate, Albany (USA). Committee on Corporations, Authorities, and Public Utilities). 17 Feb 1976. 36p. York State Senate, Albany.

Contents include: History; Natural gas potential in the New York portion of Lake Erie; New York state dependence on natural gas; Economic impact; Impact on employment; Cost of alternative fuels; Fiscal impact; The natural gas market; Environmental considerations; Safety equipment; Scenery pollution; Hazards to navigation.

PRODUCTS AND BY-PRODUCTS

8030 Conversion of natural gas to gasoline and LPG. Garwood, W.E.; Jacob, S.M.; Kuo, J.C.; Wise, J.J. (to Mobil Oil Corp.). US Patent 4,048,250. 13 Sep 1977. Filed date 8 Apr 1975. 10p.

Natural gas is steam reformed to a mixture of carbon monoxide, carbon dioxide and hydrogen which mixture is converted, over a methanol synthesis catalyst, to a mixture of methanol, carbon oxides and hydrogen which methanol is converted to C_5+ hydrocarbon gasoline, light gas and water; the water is separated out and may be recycled as steam; the portion of the hydrocarbon fraction which comprises light olefins and isobutane is subjected to acid alkylation to product very high octane hydrocarbon gasoline which is admixed with the C_5+ hydrocarbon gasoline from the methanol conversion. The light fuel gas (C_1 to C_2) produced in the methanol conversion is recycled to the steam reformer and the LPG (C_3 + C_4) produced therein is recovered and sold. 10 claims, 2 drawing figures.

8031 Converting natural gas to urea for fertilizer in Australia. Kenneady, S. pp 217-222 of In Proceedings of the fourth symposium on the development of petroleum resources of Asia and the Far East. New York; United Nations (1973).

From 4. symposium on the development of petroleum resources of Asia and the Far East; Canberra, Australia (27 Oct 1969). See CONF-691079—P2.

Development of the fertilizer industry in Australia is reviewed and the process for production of ammonia used in fertilizer manufacture is described. Discussions are included on conversion of ammonia to solid fertilizers, ammonia plant operation, and urea plant operation. A flowsheet for the ammonia and urea processes is also included. (JRD)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 8032

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 7942, 8993

POLICY, LEGISLATION, AND REGULATION

8032 (PB—268386) The natural gas shortage. Final report. Siddayao, C.M. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). Jul 1975. 41p. NTIS PC A03/MF A01.

This report traces the history of well-head controls over the prices of natural gas. It analyzes the reasons for these controls and then assesses their impact on investment in exploration and production in the industry.

TRANSPORT, PIPELINES, AND HANDLING

8033 (PB—268038) Legal aspects of the ocean carriage and receipt of liquefied natural gas. Sea Grant Collage Program. Swan, P.N. (Oregon State Univ., Corvallis (USA)). Mar 1977. 174p. (ORESU-T—77-001). NTIS PC A08/MF A01.

A comprehensive approach is made to various legal aspects of the transport of liquefied natural gas. Following explanations on the specific technology of LNG, consideration is given to the structural and operational safety of LNG carriers; siting of terminals and assessments of environmental risks; the financing of the carriers; the liability and insurance; the regulations; and finally, the political, national security and diplomatic problems are reviewed.

8034 Evaluation of disturbances in installations for the generation, transmission and distribution of gas. Altmann, W. (VVB Energieversorg, Leipzig, E Ger). *Energietechnik;* **27**: No. 1, 33-37(Jan 1977). (In German).

A review is presented about the development of disturbance phenomena in installations for generation, transmission and distribution of gas in East Germany. Important parameters of such disturbances are pointed out and analyzed. Conclusions are drawn concerning further increasing the reliability of supply and guidelines are presented for improving the methods for determining the disturbances. 3 refs.

8035 Location of pipeline tightness failure by measuring gas flow parameters. Rustamov, K.E. (Az SSR Polytech Inst im. Ch. Il'dryma). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 78-80(1977). (In Russian).

Relying on the solution of a reverse problem for a parabolic-type differential equation with nonuniform boundary conditions, a formula is proposed by means of which the place of tightness failure in a pipeline may be located. The solution is constructed by G.I. Barenblatt's method.

8036 New high-capacity gas turbine engines for natural gas force pumps. Bufalov, G.V.; Kuznetsov, A.L.; Bogoradovskii, G.I.; Krinskii, A.A. (PO "Nevski Works im. V.I. Lenin", USSR). *Energomashinostroenie;* No. 5, 44-45(1977). (In Russian).

A justification of the need to use high-capacity gas turbine engines to drive natural gas force pumps on the major gas pipelines in the USSR is presented. Technical characteristics of a new 25 MW gas turbine engine are given.

8037 Gathering system of the gasfields in Taiwan, China. pp 193-194 of In Proceedings of the fourth symposium on the development of petroleum resources of Asia and the Far East. New York; United Nations (1973).

From 4. symposium on the development of petroleum resources of Asia and the Far East; Canberra, Australia (27 Oct 1969). See CONF-691079—P2.

At present, there are two major gas fields in Taiwan: the Chinshui gas field with a daily production of 1.4 million m^3 of natural gas and the Tiehchenshan gas field from which the designed production rate will be 3 million m^3 of natural gas per day. The transportation system in these two fields for the gas and the condensate from the producing wells to the natural gasoline plant is either

by the two- or the three-phase flow gathering system. The design and operation of these gathering systems are discussed. (JRD)

PROPERTIES

REFER ALSO TO CITATION(S) 8040

8038 Analytical methods of determination of the coefficient of compressibility of gas and condensate mixtures. Gurevich, G.R. (Moscow Inst of Petrochem and Gaz Ind im. I.M. Gubkin, USSR). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 69-72(1977). (In Russian).

Methods of calculation of the coefficient of compressibility of gas and condensate mixtures within the range of pressure variations from 1 to 680 kgf/cm$sup 2$ and temperature variations from 273 to 477 K are analyzed. Calculation results are compared with experimental results quoted in literature. It is shown that compressibility coefficients may be calculated with the least error in accordance with the Benedict-Webb-Rubin equation of state in a reduced form with different dependence of the equation coefficients on the acentric factor, in accordance with the Srihari et al. equation in the reduced form and the Latonov-Gurevich equation.

COMBUSTION

REFER ALSO TO CITATION(S) 7909

8039 Formaldehyde formation in natural gas combustion in household appliances. Schmidt, A.; Goetz, H. (Tech Univ, Vienna, Austria). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 3, 112-115(Mar 1977). (In German).

Results of flame analysis for noxious substances and toxic aspects of formaldehyde are reported. Measuring procedures and evaluation of measurements are given. Relationships between distance of burner from vessel, and boiling time are established. 4 refs.

STORAGE

8040 Experimental investigation of the effect of gas filtration pressure on the limiting gradient value. Osmanov, E.N.; Shakhnazarov, A.M. (Az SSR Inst of Pet and Chem im. M. Azizbekov). *Izv. Vyssh. Uchebn. Zaved., Neft Gaz;* No. 2, 45-47(1977). (In Russian).

Results of experiments on the determination of the value of the initial pressure gradient during gas filtration through argillized poorly permeable core samples are presented. As a result of experiments it is found that, during the filtration of a gas through a porous medium containing clay, an initial gradient is observed which decreases with an increase in the filtration pressure.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 7800

SITE GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 8043

SITE GEOLOGY

REFER ALSO TO CITATION(S) 7929

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 8043

IN SITU METHODS, TRUE AND MODIFIED

8041 (LERC/RI—77/5) **Field experiment of reverse combustion oil recovery from a Utah tar sand.** Land, C.S.; Cupps, C.Q.; Marchant, L.C.; Carlson, F.M. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). Oct 1977. 20p. Dep. NTIS, PC A02/MF A01.

A field experiment to recover oil from tar sand by reverse combusion was conducted at Northwest Asphalt Ridge, near Vernal, Utah. This test was in a 10-ft interval of the Rim Rock sandstone member of the Mesa Verde Formation at a depth of 300 ft. Ignition was accomplished November 25, 1975, and the reverse combustion front was propagated successfully through the formation. Results of the field experiment differed significantly from the results of laboratory tests that were used in the design of the field test. This difference is attributed primarily to the extreme heterogeneity of the tar sand formation. Observed temperatures in the burned area were lower than expected, but a large portion of the tar sand within the pattern boundaries was heated to the extent that the bitumen became mobile enough to be produced. After 3½ weeks of operation, the project was terminated because of the inability of the surface production equipment to accommodate the heavy hydrocarbons being produced. Although the formation of the cracked products of reverse combustion was less than expected, this recovery process may be used successfully to heat the tar sand reservoir to a temperature high enough that the bitumen becomes mobile enough to be produced.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 7859

8042 (LERC/RI—77/4) **Combustion rates for oil shale carbonaceous residue.** Dockter, L.; Turner, T.F. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). Aug 1977. 24p. Dep. NTIS, PC A02/MF A01.

The combustion rate of the residual carbon remaining in retorted oil shale was investigated using oil shale core samples. Laboratory data indicates the combustion front penetration rate is proportional to the square root of time and increases linearly with the square root of the sweep gas oxygen concentration, implying an ash layer diffusion control mechanism. Equations are presented relating the residual carbon combustion rate to shale richness and the oxygen concentration in the sweep gas.

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 9017

8043 (ERDA—116(Vol.5)) **Balanced program plan: analysis for biomedical and environmental research. Volume 5. Oil shale technology.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Biomedical and Environmental Research). Jun 1976. Contract W-7405-ENG-38. 42p. Dep. NTIS $4.00.

Oil shale technology has been divided into two sub-technologies: surfaceprocessing and in-situ processing. Definition of the research programs is essentially an amplification of the five King-Muir categories: (A) pollutants: characterization, measurement, and monitoring; (B) physical and chemical processes and effects; (C) health effects; (D) ecological processes and effects; and (E) integrated assessment. Twenty-three biomedical and environmental research projects are described as to program title, scope, milestones, technology time frame, program unit priority, and estimated program unit cost.

FISSION FUELS

RESERVES

8044 (NP—22434) **South Texas uranium province: geology and extraction.** Galloway, W.E.; Groat, C.G. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1976. 16p. of Texas, Austin.

The increasing demand for uranium combined with the improving economics of uranium production have resulted in a significant upsurge in exploration and mining efforts in the South Texas Coastal Plain uranium province. Texas ranks third in U.S. uranium production. Today, potentially commercial deposits have been delineated along an arcuate belt that stretches more than 250 miles from the Rio Grande into the middle Coastal Plain. The extent of these known deposits, both areally and stratigraphically, combined with the large areas that remain little-explored suggest an ultimate ore reserve potential that could significantly affect the economy of the State.

8045 Mode of uranium occurrence in a migmatitic granite terrain, Baie Johan Beetz, Quebec. Hauseux, M.A. (McGill Univ, Montreal, Que). *CIM Bull.;* **70**: No. 780, 110-116(Apr 1977).

The Turgeon Lake granite lies 5 miles north of Baie Johan Beetz, Quebec, at the eastern margin of the Grenville Province. The rocks are classed as granites, granulites, quartzites, biotite schists and

gneisses, and amphibolites. The granite's uraniferous character is manifested by phosphuranylite, uraninite, and metamict zircons associated with magnetite. A uranium reconcentration into fold-axial zones from original sediments which have been highly granitized during at least two phases of folding is suggested from the available data. 13 refs.

8046 New genetic model for uranium-copper mineralization, Permo-Carboniferous basin, northern nova scotia. Dunsmore, H.E. (Geol Surv of Can, Ottawa, Ont). *Geol. Surv. Can., Pap.;* No. 77-1B, 247-253(1977).

A number of uranium-copper occurrences in Upper Carboniferous sandstones of northern Nova Scotia have been designated as the Pugwash-Tatamagouche style of mineralization. The scattered occurrences bear a striking resemblance, both in style of mineralization and geological setting, to deposits of the Colorado Plateau area of the southwestern United States. A newly developed metallogenetic model suggests that the mineralizing solutions, together with most of the uranium for this type of deposit, were derived from thick sequences of underlying marine evaporites. Should the model be valid, significant uranium resources not suspected hitherto may be found in the Pugwash-Tatamagouche district of northern Nova Scotia. 20 refs.

8047 Uranium resources of the Permo-Carboniferous basin, Atlantic Canada. Dunsmore, H.E. (Geol Surv of Can, Ottawa, Ont). *Geol. Surv. Can., Pap.;* No. 77-1B, 341-348(1977).

As part of the uranium resource evaluation program of the Geological Survey of Canada, a two-man, geological reconnaissance of the Permo-Carboniferous sedimentary basin of Atlantic Canada was conducted during the 1976 field season. Parts of all four Atlantic provinces and the Magdalen Islands were visited. The short-term objectives of this survey were fourfold: (1) to examine all reported occurrences in Carboniferous strata; (2) to prospect for additional surface occurrences; (3) to formulate a preliminary classification system; and, (4) to assign priorities to future, more comprehensive research. The long-term objective of this project is to assess as accurately as possible the potential uranium resources of the area. 20 refs.

8048 (LA-tr—77-50) **Anomalies in the natural occurrence of ^{239}Pu.** Meier, H.; Boesche, D.; Zeitler, G.; Albrecht, W.; Hecker, W.; Menge, P.; Unger, E.; Zimmerhackl, E. Translated from *Radiochim. Acta;* **21**: 110-116(1974). 20p. Dep. NTIS, PC A02/MF A01.

Volcanic samples from different locations and eruptions were found to have uranium contents in the range from 0.1 to 2 ppM and ^{239}Pu contents of the order of 10^{-14} g/g, as measured by alpha-spectrometry. Thus the corresponding ^{239}Pu/^{238}U-ratios reach values up to 10^{-7}, several orders of magnitude higher than the value of 3 x 10^{-12}, which is typical for uranium minerals. These results agree with those of Cherdyntsev et al, who found ^{239}Pu/^{238}U ratios up to 10^{-5} in volcanic samples. A contamination by ^{239}Pu from fallout is out of the question. Build-up from ^{238}U by neutron capture cannot provide an explanation on the basis of the neutron flux densities normally supposed to exist in the crust of the earth, at least as long as one may not assume natural chain reactions of the type of the prehistoric Oklo "nuclear reactor" to occur near volcanic magmas. In this connection, the possible relation between ^{239}Pu anomalies and the natural occurrence of super-heavy elements, as discussed by Cherdyntsev et al., gains a new interest.

EXPLORATION

REFER ALSO TO CITATION(S) 8046, 8116, 8117, 8118

8049 (GJBX—46(77)(Vol.1)) **Development of a USERDA dynamic test range for calibration of airborne gamma radiation measuring systems.** (Geodata International, Inc., Dallas, Tex. (USA)). 17 Nov 1976. Contract EY-76-C-13-1664. 100p. Dep. NTIS, PC A05/MF A01.

The Dynamic Test Range has been developed for the United States Energy Research and Development Administration for the purpose of providing a surface region over which airborne gamma radiation measuring systems may be calibrated for measurement of surface concentrations of eU, eTh and K. Different airborne gamma radiation detector configurations will have different spectral energy responses for the measurement of the gamma radiation emitted from the decay daughters of thorium and uranium and from ^{40}K, and different gamma ray energy intervals may be used to reduce the data. Therefore, the "Dynamic Test Range" is provided in order to have all airborne systems supply data on the same basis. A complete description of the Dynamic Test Range is presented including location maps, climate and hydrology, soils and vegetation, geology and surface geophysical data. Results of surface soil analyses are included. Calibration data are presented in Volume II of this report for six flight paths at altitudes of 200, 400, 600, 800, 1000, and 1200 feet. (WHK)

8050 (GJBX—46(77)(Vol.2)) **Lake Mead dynamic test range for calibration of airborne gamma radiation measuring systems.** (Geodata International, Inc., Dallas, Tex. (USA)). 1977. Contract EY-76-C-13-1664. 76p. Dep. NTIS, PC A05/MF A01.

Data are presented for calibrating airborne gamma radiation measuring systems for surface concentrations of U, Th, and K. Data are included for six flight paths at altitudes of 200, 400, 600, 800, 1000, and 1200 feet. Lake Mead Dynamic Test Range is described in detail in Volume I of this report. (WHK)

8051 (K/UR—5) **National Uranium Resource Evaluation program. Uranium geochemical survey in the Crystal City and Beeville Quadrangles, Texas.** Nichols, C.E.; Butz, T.R.; Cagle, G.W.; Kane, V.E. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 11 Feb 1977. Contract W-7405-ENG-26. vp. (GJBX—19(77)). Field Eng. Corp., Grand Junction, CO.

A uranium geochemical survey was conducted in the Crystal City and western half of the Beeville Quadrangles, Texas, an area of approximately 34,000 km^2. Using the Texas Gulf Coast Uranium Province as a study area, this survey demonstrates the applicability of a 2 phase hierarchical sampling program with multielement analysis of the samples for regional geochemical reconnaissance for uranium. Phase I samples of stream sediment, stream water, and well water were collected from drainage basins with a target drainage of 250 km^2 to identify uranium province lines which define the area in which closer spaced Phase II sampling should be conducted. Phase II samples of stream sediment, stream water, well water, and tree branches were collected from drainage basins with a target drainage of 25 km^2 in order to identify uranium district lines. Stream sediment, stream water, well water, and ash of tree branches were analyzed for approximately 25 parameters. The most useful sample type for identifying potential uranium mineralization in the Texas Gulf Coast is well water. Wells were found to accurately distinguish both province lines at Phase I sample spacing and district lines at Phase II sample spacing by several methods of evaluation. Results of the survey indicate that the concept of 2 phase sampling with multielement analyses of samples, developed by the ORGDP Project, may yield good results for the remainder of the area to be surveyed by ORGDP with modifications for different geologic regions.

8052 (LA—6935-PR) **Geostatistics project of the National Uranium Resource Evaluation Program, April—June 1977.** Zeigler, R.K.; Susco, D.V.; Wecksung, G.; Campbell, K.; Bement, T.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 16p. Dep. NTIS, PC A02/MF A01.

Data collected by Geodata International, Inc., on the air reconnaissance of the 1° by 2° Lubbock Quadrangle were analyzed. Spline smoothing followed by subsampling of records was done in an investigation of the feasibility of reducing the data set to a more manageable size. A computerized method of contouring irregularly spaced points has been implemented and used on the Lubbock data set. The reduced data set was also used to prepare gray-level and pseudocolor maps of the potassium, bismuth, and thallium signals in the Lubbock Quadrangle. Some exact probabilities have been computed for the method of identifying significant clusters of anomalies which was discussed in the first report of this series. An improved, efficient method of approximating the exact probabilities has also been developed. Preliminary analyses were done on data from the Lake Meade Dynamic Test Range and the calibration pads of the Grand Junction, Colorado, airport.

8053 (SAND—77-0300) **Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1977. Contract EY-76-C-04-0789. 87p. (GJBX—23(77); CONF-770249—). Dep. NTIS, PC A05/MF A01.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

This is the first of a series of seminars on pulsed neutron logging of uranium boreholes by the Prompt Fission Neutron Technique, and on neutron tube technology. The purpose of these seminars is to aid in the transfer of technology from government-sponsored research to private industry utilization. The documentations in this report are extended abstracts of the presentations given at the seminars. Separate abstracts were prepared.

8054 (SAND—77-0300, pp 6-22) **Theory and basis of PFN logging.** Jensen, D.H. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

The prompt fission neutron (PFN) logging technique is a method for assaying for uranium mineralization surrounding test

boreholes. A neutron generator is used as a pulsed source of neutrons. The neutron theory on which the technique is based, the response of a formation to a neutron burst, computer calculations used to analyze the response, and the variation of formation parameters is discussed. The components are the PFN logging probe are briefly described. (JSR)

8055 (SAND—77-0300, pp 23-34) **Description of PFN logging probe.** Heiser, M.R. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

Sandia's pulsed prompt fission neutron (PFN) uranium logging probe is 3.36 metres long and 70 millimetres in diameter. The probe case is 304 stainless steel with a wall thickness of 3 millimeters and should withstand 20 megapascals (2900 psi) of pressure. The weight of the assembled probe is 40 kilograms. It is composed of six modules: (1) The TTA (tube transformer assembly) which combines the 14 MeV neutron source with its high-voltage driving transformer. (2) The pulse forming network which produces timed and shaped pulses to drive the TTA. (3) The reservoir control circuit which controls the gas pressure in the neutron generator. (4) The neutron generator (prompt) monitor/thermal monitor, the first of which continuously monitors the output of the neutron generator, the second of which monitors the level of thermal neutrons through observation of capture gammas. (5) The proportional counter which monitors the epithermal neutron returns. (6) The high-voltage converter which converts the 500 volts d.c. sent downhole to probe operating voltages. Descriptions of, and schematics for, four of these modules are given. The TTA and pulse forming network modules are described later.

8056 (SAND—77-0300, pp 35-45) **Uphole instrumentation and operations.** Stephenson, W.A. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

The Sandia PFN Logging System, which includes the probe and uphole instrumentation, is a laboratory development model, a collection of commercial and lab constructed instrumentation assembled to accomplish a task. The function of the uphole instrumentation is to collect and store the data necessary for uranium borehole analysis. The uphole components and operations that are described include the cable, logging vehicle, probe operation and logging, and calibration and maintenance. The improvements necessary to the system are discussed. (JSR)

8057 (SAND—77-0300, pp 46-61) **Log interpretation techniques.** Smith, G.W.; Barnard, R.W. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

Field data taken with the prototype PFN logging probe are recorded in both digital and analog form. The analog data must be corrected for the attenuation factor, the count rate dead time, and the variation of the neutron generator output in order to obtain a valid expression for the ore grade. The digital data is analyzed using the Czubek model. Both methods of data reduction can produce acceptable agreement with core assay data. The Czubek method is inadequate, however, for describing the magnitude of uranium grade over conditions ranging from concrete test pits to saturated sandstone. Efforts are being made to improve this model. (JSR)

8058 (SAND—77-0300, pp 82-85) **Plans for PFN probe technology.** Bivens, H.M. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

An outline is given of development plans and proposed technology transfer activities for the PFN logging system. (JSR)

MINING

8059 **Significant growth in mines power demand.** *Coal, Gold Base Miner. South. Afr.;* 89, 91, 93(May 1977).

This report by the Department of Planning and the Environment looks at present and future power requirements by the mines.

8060 **Review of the uranium industry in the U.S.A.** Davis, J.R. (Rocky Mountain Energy Co., Denver, Colorado (USA)). pp 109-112 of In Geology, mining and extractive processing of uranium. An international symposium, co-sponsored by the Institution of Mining and Metallurgy and the Commission of the European Communities, London, 17-19 January, 1977. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From International symposium on geology, mining and extractive processing of uranium; London, UK (17 - 19 Jan 1977).

The 145 000 MWe of nuclear capacity that will be operational in the U.S.A. by 1985 will demand an annual production of U_3O_8 of 39 000 tons (the 1976 figure is 17 000 tons). The short term pressures on the uranium industry to expand mining and milling capacity and the long-term pressures to discover more uranium and to increase basic reserves are therefore readily apparent. Milling capacity, for example, must grow from 28 000 tons of ore per day at present to 145 000 ton/day by 1985. In the face of these estimated requirements it is clear that changes in traditional exploration, mining and milling methods must take place. Current and possible future developments in exploration, mining and processing in the U.S.A. are outlined, as are the effects of increasingly important political and environmental considerations. Finally, mention is made of the governmental program which is designed to provide industry with the data and technology needed for exploration and mining and to assess American uranium resources.

FEED PROCESSING

8061 (PEL—253) **Recent trends in research and development work on the processing of uranium ore in South Africa.** James, H.E. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jul 1976. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The rapid increases in the price of gold and uranium in recent years have coincided with an unprecedented increase in working costs at South African gold mines. A re-examination of the existing flowsheets for the recovery of uranium, gold, and pyrite from Witwatersrand ores, in the light of these economic trends, has resulted in the identification of a number of profitable areas for research and development. The main topics under investigation in South Africa in the processing of uranium ore are the use of physical methods of concentration such as flotation, gravity concentration, and wet high-intensity magnetic separation; the wider adoption of the 'reverse leach', in which prior acid leaching for uranium improves the subsequent extraction of gold; the use of higher leaching temperatures and higher concentrations of ferric ion in the leach to increase the percentage of uranium extracted, including the production of ferric ion from recycled solutions; the application of pressure leaching to the recovery of uranium from low-grade ores and concentrates; the development of a continuous ion-exchange contactor capable of handling dilute slurries, so that simpler and cheaper techniques of solid-liquid separation can be used instead of the expensive filtration and clarification steps, and the improvement of instrumentation for the control of additions of sulphuric acid and manganese dioxide to the leach. A brief description is given of the essential features of the new or improved processing techniques under development that hold promise of full-scale application at existing or future uranium plants.

8062 **Ferrous iron oxidation and uranium extraction by Thiobacillus ferrooxidans.** Guay, R. (Laval Univ., Quebec); Silver, M.; Torma, A.E. *Biotechnol. Bioeng.;* **19**: No. 5, 727-740(May 1977).

The microbiological oxidation of ferrous iron in batch and continuous systems has been investigated in relation to uranium extraction from a low-grade ore by Thiobacillus ferrooxidans. The influence of the parameters, agitation, and aeration on oxygen saturation concentration, rate of oxygen mass transfer, and rate of ferrous iron oxidation was demonstrated. The kinetic values, V/sub max/ and K were determined using an adapted Monod equation for different dilution rates and initial concentrations of ferrous iron. The power requirements for initial, leaching conditions were also calculated. Uranium extraction as high as 68 percent has been realized during nine days of treatment. Regrinding the leach residue and its subsequent leaching yielded 87 percent uranium solubilization.

ENRICHMENT

8063 (NP—22489) **Uranium enrichment: alternatives for meeting the nation's needs and their implications for the federal budget. Background Paper No. 7.** Dowd, R.M. (Congressional Budget Office, Washington, D.C. (USA)). 18 May 1976. 88p. GPO $1.35.

Most projections indicate that the nation's use of electricity generated by nuclear (fission) power will continue to increase.

Today's nuclear power plants are fueled by ^{235}U; uranium must be "enriched" before it can be used. The country's three uranium enrichment facilities are owned by the federal government and managed by ERDA. These facilities, with some expansions already planned, will be adequate only until the mid-1980s. A bill, the Nuclear Fuel Assurance Act (NFAA) (S. 2035, H.R. 8401) would authorize private ownership of uranium enrichment facilities. This proposal has focused debate on whether the government should continue to own all such facilities or whether some or all facilities should be owned by the private sector. Several ownership options and their potential budget impacts are discussed. (DLC)

LASER EXCITATION

REFER ALSO TO CITATION(S) 8114

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 8073, 8354, 8355, 8356, 8357, 8404

8064 (ZfK—312, pp 16-18) **Fabrication of compact spherical UO_2 particles.** Quaritsch, K.; Eichler, R.; Rausendorf, P.; Raetzsch, W. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Jul 1976. (In German).

In Annual report, 1976.

Uranium hexafluoride was converted into uranium oxide by steam and hydrogen in a fluidized bed using uranium dioxide as a seed material. The fluidization zone was divided into a deposition zone and a purification zone by a tube inserted in the reactor.

8065 Furnace for the continuous sintering of pellets of ceramic nuclear fuel material. Heyraud, J. (to Commissariat a l'Energie Atomique). US Patent 4,047,886. 13 Sep 1977. Filed date 24 Nov 1975. 4p.

The furnace comprises a hearth for the longitudinal displacement of pellet containers, means for injecting gas at both ends of the furnace, for sucking gas between preheating and sintering zones and for condensing the binder, means for displacing the containers from an introduction lock-chamber to an extraction lock-chamber, a conveyor belt which passes through a glove box and provides a leak-tight connection between the lock-chambers. A station for loading containers with pellet sub-containers prior to sintering and a station for unloading the pellet sub-containers after sintering are juxtaposed within the glove box. 3 claims, 1 drawing figure.

8066 Processing and composition control of weak-acid-resin-derived fuel microspheres. Weber, G.W.; Beatty, R.L.; Tennery, V.J. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **35**: No. 2, 217-226(Sep 1977).

The current recycle fissile fuel for steam cycle high-temperature gas-cooled reactors in the U.S. is derived from weak acid ion-exchange resin microspheres loaded with uranyl ions. This material offers great versatility in the control of chemical and physical properties through careful process control. Processing the upgraded loaded resin begins with thermal decomposition or carbonization, which yields finely dispersed UO_2 in a porous carbon matrix. This step requires a controlled heating rate from 350 to 450°C, and is complete by approximately 900°C. If carbide or mixed-oxide/carbide fuel is desired, carbothermic reduction, or conversion, is done at 1500 to 1750°C. This step reduces the UO_2 to UC_2 to optimize irradiation performance. Physical properties after carbonization correlate with the observed thermogravimetric behavior. The mercury density, volume decrease, weight loss, bulk density, carbon content, and particle size depend strongly on the particular heating rate employed through the 350 to 450°C region. The conversion process generally follows the anticipated thermodynamic behavior for removal of carbon monoxide based on its partial pressure. The particular phases present after conversion can be manipulated by controlling the conversion temperature or by additions of hydrogen or carbon monoxide to the fluidizing gas.

8067 Quality control techniques for procarbon. Delle, W. (Kernforschungsanlage, Juelich, Ger.); Koizlik, K.; Price, M.S.T.; Wallura, E. *Nucl. Technol.;* **35**: No. 2, 284-292(Sep 1977).

Today, pyrocarbon (PyC) is the most common material used for the coating of nuclear fuel particles for the fuel elements of the high-temperature gas-cooled reactor. During recent years, many procedures have been developed for this material that have yielded a broad spectrum of information and have thereby improved knowledge of PyC. The characterization methods that are suitable for outline quality control include coating layer density determination by sink float techniques, coating layer thickness by x-ray projection or by contact microscopy, and orientation anisotropy. Many other techniques are available for laboratory use.

8068 Quantitative chemical method for the determination of the disordered carbon component in pyrocarbon coatings of fuel particles. Wolfrum, E.A.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 293-300(Sep 1977).

The chemical behavior of the surface of pyrocarbon (PyC) coatings of nuclear fuel particles was investigated in aqueous suspension by reaction with oxygen at room temperature. The concentration of the disordered material component, which has a large internal surface, can be identified by means of a pH change. Using this fact, a chemical method was developed that can be used for the quantitative determination of the concentration of this carbon component in the PyC coating.

8069 Chemical vapor deposition of ZrC made by reactions of $ZrCl_4$ with CH_4 and with C_3H_6. Hollabaugh, C.M.; Wahman, L.A.; Reiswig, R.D.; White, R.W.; Wagner, P. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **35**: No. 2, 527-535(Sep 1977).

The experimentally determined quantitative effects of varying gas mixture composition on the properties of the zirconium carbide (ZrC) deposited on microspheres in a fluidized bed were a decrease in metallic appearance of the ZrC coat, with an increase in the ratio of the hydrocarbon gas to the $ZrCl_4$ and co-deposition of carbon at high hydrocarbon gas concentrations. Increasing the H_2 concentration inhibited these effects and permitted the ZrC to be deposited at higher hydrocarbon gas concentrations. Deposits of pure substoichiometric ZrC coats were controllable over a limited concentration range. The ZrC was deposited in a fluidized bed of ThO_2 particles at a maximum temperature of approximately 1650°K, using gas mixtures of H_2, argon, $ZrCl_4$, and CH_4 or C_3H_6. The $ZrCl_4$ flow was controlled using a powder feeder.

8070 Process for the preparation of graphite-clad nuclear fuel rods. Iwamoto, K.; Tobita, T.; Masuyama, T.; Yamazoe, H. (to Nippon Carbon Co., Ltd.; Atomic Energy Research Inst.). US Patent 4,045,526. 30 Aug 1977. Priority date 22 Mar 1974, Japan. 6p.

A process for the preparation of graphite-clad nuclear fuel rods comprises coating fine particles of a nuclear fuel such as uranium oxide or thorium oxide with a matrix material containing graphite powder and a binder to form matrix material-coated globules, charging the thus-formed globules, without or after being premolded into a green rod-like fuel compact, into the rubber mold of a rubber press molding machine, charging a similar matrix material in the gap between the globules or rod-like fuel compact and the inner wall of the rubber mold, compressing the whole mass in the direction from the side face of the whole mass to the axis thereof to form a green, graphite coat material-coated fuel compact, baking the thus-formed green fuel compact at a temperature of up to 1800°C and, if desired, impregnating the baked product with a resin followed by being rebaked at a temperature of up to 1800°C; and the graphite-clad nuclear fuel rods. 10 claims, 12 drawing figures.

8071 Effects of processing variables on HTGR fuel kernels fabricated from uranium-loaded cation-exchange resin. Johnson, D.R.; Lackey, W.J.; Sease, J.D. (oak Ridge Natl Lab, Tenn). *Am. Ceram. Soc. Bull.;* **56**: No. 6, 567-571(Jun 1977).

An experiment was performed to determine whether the process for refrabricating HTGR fuel microspheres could be reasonably controlled if scaled up to engineering-scale, fluidized bed equipment. Effects of gas flow rate, heating rate and oxide to carbided conversion temperature and time on the composition, size, shape and density of the fuel kernels were determined in a statistically designed and analyzed experiment. 20 refs.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 8095, 8101, 8384

8072 (CEA-R—4805) **Behavior of Nb fission product during nuclear fuel reprocessing.** Gue, J.P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif; Paris-6 Univ., 75 (France)). Feb 1977. 94p. (In French). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

Investigations on niobium fission product behavior in nitric acid and tributyl phosphate media have been carried out in order to explain the difficulties encountered in separating this element from fissile materials during spent nuclear fuel reprocessing. The studies have shown that in nitric acid solution, pentavalent niobium has a colloidal hydroxide form. The so-obtained sols were characterized by light scattering, electronic microscopy, electrophoresis and ultracentrifugation methods. In heterogeneous extracting media containing tributyl phosphate and dibutyl phosphoric acid the niobium hydroxide sols could be flocculated by low dibutyl phosphoric acid concentration or extracted into the organic phase containing an excess of dibutyl phosphoric acid.

8073 (HEDL-TC—902-1) **HEDL contribution to SRL fuel recycle program. Quarterly report, January—March 1977.** Fletcher, J.F. (Hanford Engineering Development Lab., Richland, Wash.

(USA)). Aug 1977. Contract EY-76-C-14-2170. 44p. Dep. NTIS, PC A03/MF A01.

Research on LWR fuel cycle is being done in the following categories: economic studies (sensitivity analysis of LMFBR fuel fabrication costs), spent fuel receipt and storage (failure of PWR and BWR fuel assemblies), fuel materials preparation or finishing processes, reduction of TRU waste generation, and environmental impacts. 12 tables. (DLC)

8074 (KFK—2255, pp v) **Chemical engineering developments on the reprocessing process of 1965 to 1975 in the Institute for Hot Chemistry.** Baumgaertner, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie). Aug 1976. (In German).

In Compilation of papers for the 1st status report of the project 'reprocessing and waste treatment', November 17, 1975.

A report is given on the development work carried out in the past 10 years for aqueous reprocessing of LWR fuel elements in the Institute for Hot Chemistry of the Gesellschaft fuer Kernforschung. Laboratory and technical systems (LABEX, Milli, Tamara) for the optimization of Pu-U extraction, process control, as well as the reprocessing method in the Milli system are described. Finally, the most important topics of development in reprocessing in the years to come are dealt with.

8075 (KFK—2255, pp v) **Experience gained in the operation of reprocessing of LWR-fuels in the WAK.** Huppert, K.L. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Eggenstein-Leopoldshafen (Germany, F.R.)). Aug 1976. (In German).

In Compilation of papers for the 1st status report of the project 'reprocessing and waste treatment', November 17, 1975.

A report is given on technical improvements in the reprocessing plant Karlsruhe (WAK) and on their effect on the operational behaviour.

8076 (KFK—2255, pp v) **Development and status of the industrial fuel reprocessing in the Federal Republic of Germany.** Issel, W. (Kernbrennstoff-Wiederaufarbeitungsgesellschaft m.b.H., Eggenstein-Leopoldshafen (Germany, F.R.)). Aug 1976. (In German).

In Compilation of papers for the 1st status report of the project 'reprocessing and waste treatment', November 17, 1975.

The author gives a survey of the industrial concept of the German reprocessing plant, quotes costs per ton of annual reprocessing capacity and deals with the risk of industrial reprocessing.

8077 (KFK—2255, pp v) **In-line instrumentation and computer-controlled process control in reprocessing.** Mache, H.R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik); Groll, P. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie). Aug 1976. (In German).

In Compilation of papers for the 1st status report of the project 'reprocessing and waste treatment', November 17, 1975.

A sufficient process control is aimed at for rational, reliable and safe process guiding in reprocessing. Flow rate, pressure, temperature and liquid level concentrations of uranium, plutonium, acids and fission products are to be determined. The authors firstly give a survey of the in-line measuring equipment available at present for the continuous measurement of concentrations in radioactive process solutions and then deal with computer-controlled data acquisition and processing using the example of the process control system TAMARA.

8078 (KFK—2255, pp v) **Head-end off-gas purification.** Weinlaender, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie). Aug 1976. (In German).

In Compilation of papers for the 1st status report of the project 'reprocessing and waste treatment', November 17, 1975.

Following the explanation of the term 'head-end', the author deals with the problems of the head-end off-gas purification in reprocessing. A report is given on the tasks and the choice of method for waste gas purification, on the apparatus models, state of development in the GfK, as well as on achievable decontamination factors in waste gas treatment.

8079 (KFK—2255, pp v) **Removal of aerosols and iodine from the head-end off-gas of a fuel reprocessing plant.** Wilhelm, J.G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Lab. fuer Aerosolphysik und Filtertechnik); Furrer, J. Aug 1976. (In German).

In Compilation of papers for the 1st status report of the project 'reprocessing and waste treatment', November 17, 1975.

Within the framework of the reprocessing and waste treatment project (PWA) of the GfK, work on the separation of suspended matter and fission iodine from the resolver waste gas of reprocessing plants was carried out. In the first part of the report, the authors present a method concept to separate aerosols and they report on running studies. The decontamination factor for radionuclides occuring in aerosol form is estimated. In the second part, a report is given on required degrees of separation of iodine 129/131, on the desorption method of fission iodine for separation from the fuel solution, the separation of iodine by means of wet washing methods and on solid sorption materials, on materials harmful to iodine filters and on the design of the iodine filter for a reprocessing plant.

8080 (KFK—2396) **Experiments on reprocessing of fast breeder reactor fuel in the pilot plant MILLI.** Ochsenfeld, W.; Baumgaertner, F.; Bleyl, H.J.; Ertel, D.; Koch, G.; Warnecke, E. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Feb 1977. 33p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The report describes the reprocessing of 2.7 kg of highly irradiated UO_2-PuO_2 fast breeder fuel in the experimental facility MILLI of the Institut fuer Heisse Chemie (IHCH). The fuel contained 15% PuO_2, the initial uranium enrichment was 60% ^{235}U, and the cladding material was stainless steel. The fuel had been prepared in England by coprecipitation of UO_2 and PuO_2 and calcination, and had been irradiated in the Dounreay Fast Reactor to a burn-up level of 61,000 MWd/t. The cooling time was ca. 7 years. The material dissolved essentially completely in boiling nitric acid at HNO_3 concentrations %T $>=$ 8 moles/l. Insoluble residues amounted to $< 0.7\%$, and were analysed for U, Pu and fission products; less than 0.08% of the total fissile material remained in the insolubles. The separation of U and Pu from fission products was carried out by a modified Purex process designed at IHCH Karlsruhe for the suppression of crud formation; this process is characterized by a high HNO_3 concentration (3 to 3.5 moles HNO_3/l) and a high organic loading (ca. 110 g U + Pu/l) in the first extraction cycle. A smooth and undisturbed operation was observed over the whole campaign of 30 hours duration, thereby demonstrating for the first time the effectiveness of this flowsheet with a mixer-settler facility on a high-activity level. The U/Pu separation was carried out in the third extraction cycle with an electrolytic multi-stage mixer-settler (EMMA), using the in-line electrolytic process developed by IHCH Karlsruhe, thereby demonstrating for the first time the effectiveness of this process with high-burn-up fuel. Losses of U and Pu over the whole reprocessing campaign were low.

8081 **In-line determination of fissile material in high-activity solutions.** Schulze, G.; Wuerz, H. (Kernforschungszentrum, Karlsruhe, Ger.). *Nucl. Technol.;* **35**: No. 3, 663-670(Oct 1977).

A determination of fissile material concentration in high-level radioactive solutions can be accomplished by measuring the source multiplication of an external neutron source. Computer calculations and laboratory experiments were used to demonstrate the applicability of the method to fissile material solutions containing unknown quantities of homogeneous neutron poison materials. A relation between the fissile material concentration C/sub fiss/ and the quantities thermal and epithermal leakage neutron fluxes measured with ^{235}U fission chambers is derived. The accuracy obtained using a ^{252}Cf neutron source of source strength 5×10^8 n/s, a measuring time interval of 20 s, and assuming C/sub fiss/ to be at least twice the minimum detectable concentration is better than 30%. This is adequate for application of the method for process control of pulsed columns in reprocessing plants.

8082 **Reprocessing - the 'small countries' view.** Marshall, P. *Nucl. Eng. Int.;* **22**: No. 257, 33-34(May 1977).

Some of the financial and technological risks which face the small countries which have a need for reprocessing, but which are unable to build, or partake in other plants, are discussed. Should the vitrification-process fail, reprocessing by United Reprocessors GmbH could be replaced by storage. Reference is made to the Swiss waste concept and possibilities of storage in Switzerland.

8083 **Economic and environmental benefits of reprocessing and recycle.** Masters, R. *Nucl. Eng. Int.;* **22**: No. 257, 31-33(May 1977).

Recently published reports and papers on the economic, environmental and resource conservation benefits of reprocessing and the recycle of plutonium in thermal reactors provide an important background to the essentially political discussions in the United States on non-proliferation. Some of the main arguments and conclusions are presented.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 8073, 8314

MARKETING AND ECONOMICS

8084 **European needs for uranium in relation to world supply and demand.** Davis, M. (Commission of the European Communities, Brussels (Belgium)). pp 1-7 of In Geology, mining and extractive processing of uranium. An international symposium, co-sponsored by the Institution of Mining and Metallurgy and the Commission of

the European Communities, London, 17-19 January, 1977. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From International symposium on geology, mining and extractive processing of uranium; London, UK (17 - 19 Jan 1977).

The paper explains why Western Europe, and in particular the European Community, is engaged in an important diversification of energy sources to nuclear generated electricity. The resulting Western European demand for uranium (most of which will have to be imported) is quantified and discussed in relation to the needs of North America and Japan and the latest estimates of world uranium resources and production capability. The European Community will be the largest purchaser of uranium from a variety of sources on the world market. It is shown that the lower limits of past estimates for uranium demand appear to be the most reliable so far; the causes and effects of uncertainty for the future are outlined; and the need for exploration is emphasized. It is maintained that although close collaboration between electricity utilities and mining companies is highly desirable, the goal of an orderly market (which should be achievable for uranium) will not be achieved without a positive and constructive contribution being made by public authorities.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 8074

8085 (ARH-ST—141) **Decommissioning of Division of Military Application equipment at Hanford. Summary report.** Raile, M.N. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-06-2130. 41p. Dep. NTIS, PC A03/MF A01.

This report describes the successful decommissioning of plutonium-contaminated equipment used for weapon component fabrication and inspection at the Hanford Plant. Special materials, techniques, and equipment were employed during the course of the decommissioning program. Most significant was the development and design of large, double-wall fiberglassed plywood boxes for long-term (20-years, minimum) retrievable storage of the contaminated equipment in underground transuranic waste trenches.

8086 (KFK—2384) **Analytical model for computation of reliability of waste management facilities with intermediate storages.** Kallweit, A.; Schumacher, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung). Jan 1977. 62p. Dep. NTIS (US Sales Only), PC A04/MF A01.

A high reliability is called for waste management facilities within the fuel cycle of nuclear power stations which can be fulfilled by providing intermediate storage facilities and reserve capacities. In this report a model based on the theory of Markov processes is described which allows computation of reliability characteristics of waste management facilities containing intermediate storage facilities. The application of the model is demonstrated by an example.

8087 (PB—269857) **Determination of performance criteria for high-level solidified nuclear waste. Draft technical report, Jun 1976—Feb 1977.** Cohen, J.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. 227p. NTIS PC A11/MF A01.

A systems analysis model was developed to identify potential release points and release mechanisms for radioactive materials contained in solidified high level radioactive waste. The model considers both normal operation and potential untoward events during the handling, storage, transportation, and storage of high level wastes. The effect of varying the waste form characteristics on the probability of a release occurring, the magnetude of potential releases, and the consequences of potential releases was evaluated for each of the above operational phases of waste management in order to identify the points in the high level waste management cycle most sensitive to the waste form characteristics with regard to protecting the public health and safety. The study results will be considered by the NRC in establishing colidification requirements for high level wastes.

8088 **Radioactive wastes: a comparison of U.S. military and civilian inventories.** Krugmann, H.; von Hippel, F. (Princeton Univ., NJ). *Science;* **197**: No. 4306, 883-885(26 Aug 1977).

Contrary to widespread belief, the accumulated inventory of fission products generated by the still small U.S. civilian nuclear power industry may already be comparable to that generated in the past by U.S. military nuclear programs. Although the volumes of the military wastes are very large, they are on the average almost 100 times more dilute than projected commercial high-level wastes.

WASTE PROCESSING

8089 (BNWL—2242) **Research and Development Activities. Waste Fixation Program. Quarterly progress report, April—June 1976.** McElroy, J.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-06-1830. 40p. Dep. NTIS, PC A03/MF A01.

Research and development activities of the Waste Fixation Program for April through June 1976 are described. The objective of this program is to develop processes to convert high-level liquid waste (HLLW) from the light water reactor (LWR) fuel cycle to solid forms that are demonstrated to be physically, chemically, and radiolytically stable and inert. Several significant results were obtained during this report period. These are listed below and detailed in the text of this report. Tests of the spray calciner, fed with simulated Nuclear Fuel Services (NES) wastes, were successful. The joule-heated ceramic melter has operated continuously for more than 5 months in 1976 and for more than 16 months total. Since the last report over 2500 lb of simulated high-level waste glass have been produced while feeding dry powder calcine and slurried liquid waste. A report on water leaching at 25°C of UO_2 fuel with an average burnup of 54,500 MWD/MTU is being issued. Fluidized bed waste calcine particles were monocoated with Al_2O_3 or duplex-coated with PyC—Al_2O_3 in a fluidized bed; larger calcine pellets were formed with a disk pelletizer and coated with Pyrex frit.

8090 (BNWL—2243) **Research and Development Activities Waste Fixation Program. Quarterly progress report, July—September 1976.** McElroy, J.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-06-1830. 33p. Dep. NTIS, PC A03/MF A01.

Two engineering-scale in-can melting runs were completed. One run evaluated the melting of PW-8a-2 type waste containing cesium and ruthenium with 76-101 type frit. The other run established a melting rate of 30.9 kg/hr for an 8-in.-diam can containing a drop-in fin assembly made from an alloy having an expansion coefficient similar to that of the glass. High sodium feed was successfully spray calcined by lowering the calciner chamber temperature and using an additive in the feed material. The fluidized-bed calciner testing continued with emphasis on developing several mechanical components and engineering a hot cell installation and a full-scale prototype. A variable speed, weigh belt-type solids feeder was evaluated as a frit feeding device. A 76-183 melt composition was developed for PW-7a waste. Leach testing of thermally treated glasses was continued and feeders were evaluated. Comprehensive examination of 72-68 glass samples annealed for 1 year has been completed and has indicated no significant change over the results observed at 2 months. Additionally, characterization and identification work performed on the high-neodymium rare earth phase has indicated that an apatite-type structure exists within the temperature range of 500 to 750°C but only after a minimum time of 1 week at temperature. Preliminary impact tests on a gravity-sintered 304 stainless steel matrix demonstrate that the majority of the cracks go around, not through, the Al_2O_3 supercalcine cores. Gravity sintering parameters for stainless steel matrices have been reduced to 1050°C for 8 hr in a stagnant atmosphere, and both stainless steel Al_2O_3 and pure stainless steel spheres have been successfully fabricated.

8091 (BNWL—2290) **Nuclear waste management quarterly progress report, January—March 1977.** Platt, A.M. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1977. Contract EY-76-C-06-1830. 69p. Dep. NTIS, PC A04/MF A01.

Status of the following studies is reported: decontamination and densification of chop-leach cladding residues; monitoring methods for particulate and gaseous effluent from waste solidification processes; TRU waste fixation studies; krypton solidification; ^{14}C and ^{129}I fixation; waste management system studies; waste isolation safety assessment program; monitoring and physical characterization of unsaturated zone transport; detection and characterization of mobile organic complexes of fission products; characterization of 300 area burial grounds and electropolishing as a decontamination technique. (LK)

8092 (IAEA-R—1473-F) **Development of an integrated liquid radioactive waste management system. Part of a coordinated programme on integrated radioactive waste management systems and their impact on the environment. Final report for the period 1 July 1974 - 31 March 1976.** Pavlik, O. (International Atomic Energy Agency, Vienna (Austria)). Sep 1976. 49p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This final report discusses the theory of the air heated non-boiling evaporation and the laboratory and pilot plant experiences of simultaneous evaporation and solidification. The evaporator concentrates and dries the radioactive liquid wastes by hot air-flow circulating in closed circuit. The air is used both for heating and removal of vapors. The liquid waste becomes saturated and the salt cake is accumulated in the tank. The yield evaporation rate and the decontamination factor or ^{90}Sr and ^{137}Cs was investigated as a function to air-flow, air temperature and humidity. During the evaporation process a simultaneous cementation method was developed to fix the water soluble components of the salt cake. The leaching rate of ^{90}Sr and ^{137}Cs, the firmness and the homogeneity of the concrete were investigated.

8093 (MLM—2437(OP)) **Catalytic detritiation of water.** Rogers, M.L.; Lamberger, P.H.; Ellis, R.E.; Mills, T.K. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 7p. (CONF-770510—12). Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Montreal, Canada (May 1977).

A pilot-scale system has been used at Mound Laboratory to investigate the catalytic detritiation of water. A hydrophobic, precious metal catalyst is used to promote the exchange of tritium between liquid water and gaseous hydrogen at 60°C. Two columns are used, each 7.5 m long by 2.5 cm ID and packed with catalyst. Water flow is 5-10 cm^3/min and countercurrent hydrogen flow is 9,000-12,000 cm^3/min. The equipment, except for the columns, is housed in an inert atmosphere glovebox and is computer controlled. The hydrogen is obtained by electrolysis of a portion of the water stream. Enriched gaseous tritium is withdrawn for further enrichment. A description of the system is included along with an outline of its operation. Recent experimental data are discussed.

8094 **Nuclear waste management.** Baliga, B.B. (Saha Inst. of Nuclear Physics, Calcutta (India)). *Sci. Cult.;* **43**: No. 1, 25-29(Jan 1977).

The use of nuclear power plants for electricity generation has created the problem of management of radioactive wastes, especially high level, which if not managed properly, pose health hazards to the future generations. A long term approach in handling these wastes is necessitated by the presence of long-lived fission products in them. In the United States, wastes solidified as a glass in the steel canisters are buried in some specially chosen underground geological formation. The fission products continue to generate heat which must be dissipated to avoid melting of canisters. In this respect, as salt is more conductive than rocks, the abandoned salt mines as storage sites are preferable. Other approaches to this problem are briefly considered. In India, solidification of wastes is done by glass vitrification process.

8095 (ORNL/TM—5655) **Krypton absorption in liquid CO_2 (KALC): Campaign III in the Experimental Engineering Section Off-Gas Decontamination Facility.** Gilliam, T.M.; Fowler, V.L.; Inman, D.J. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 94p. Dep. NTIS, PC A05/MF A01.

Results are presented for the third major campaign for quantifying krypton removal from simulated High-Temperature Gas-Cooled Reactor reprocessing off-gas by the KALC process. The Experimental Engineering Section Off-Gas Decontamination Facility used in the campaign provides engineering-scale experiments with nominal gas and liquid flows of 5 scfm and 0.5 gpm, respectively. Mass transfer experiments for the CO_2—O_2—Kr system are described for the absorption, fractionation, and stripping operations of the KALC process. A detailed discussion of the data analysis is included. The analysis indicates nominal HTU values for the absorber, fractionator, and stripper on the order of 0.4, 0.5, and 0.7 ft, respectively. Flooding data for the packed columns are combined with previous data and are shown to be well represented by an empirical flooding equation.

8096 (USGS-OFR—77-321) **Volumetric properties of vapor-saturated aqueous Na_2CO_3 solutions from 0°C to 100°C, vapor-saturated aqueous K_2CO_3 solutions from 0°C to 100°C, vapor-saturated aqueous $KHCO_3$ solutions from 0°C to 50°C, and vapor-saturated aqueous $NaHCO_3$ solutions from 18°C to 60°C based on a regression of the available literature data.** Brown, D.L.; Potter, R.W. II. (Geological Survey, Reston, Va. (USA)). 1977. 16p. TIC.

Pressure-volume-temperature-composition (P-V-T-X) data for brines are required to establish optimum operating conditions for the production of geothermal brine fields. A compilation of density values is presented for vapor-saturated Na_2CO_3 solutions of 0 to 14 weight percent concentrations from 0°C to 100°C, for vapor-saturated K_2CO_3 solution of 0 to 50 weight percent concentrations from 0°C to 100°C, for vapor-saturated $NaHCO_3$ solutions of 0 to 8 weight percent concentrations at 18°C, and for vapor-saturated $KHCO_3$ solutions of 0 to 35 weight percent concentrations from 0° to 50°C. (JGB)

8097 **Conversion of waste Zircaloy hulls to zirconate ion exchange materials for waste stabilization.** Levine, H.S.; Nowak, E.J. (Sandia Labs., Albuquerque, NM). *Nucl. Technol.;* **36**: No. 1, 106-119(Nov 1977).

A new method for management of waste Zircaloy fuel hulls is proposed as an alternative to compaction and burial. It involves using the waste as a feedstock in a chemical process for preparing inorganic zirconate ion exchange material. Enough zirconate could be prepared from the waste hulls to stabilize all the high-level liquid waste generated in light water reactor fuel reprocessing, and in this way the two waste streams would be combined. The proposed conversion operation would involve chlorination of the Zircaloy waste with NH_4Cl and distillation of volatile chlorides, reaction of the distillate with isopropyl alcohol to form intermediate alkoxides, and hydrolysis of the intermediate to form the zirconate. The conversion would be accomplished with recycle of all reagents so that no new major waste stream would be created. The chemical basis for the conversion process, simplified process flowsheets, and an analysis of the various options illustrate the feasibility of the full-scale process. A preliminary economic study was made that indicated that the full-scale operation should be technically and economically feasible.

8098 **Nuclear fuel cycle: an appraisal.** Anon(NONE). *Phys. Today;* **30**: No. 10, 32-39(Oct 1977).

The APS Study Group finds existing technology and straightforward extensions sufficient for managing nuclear wastes, but unresolved economic, institutional and political questions cloud the commercial use of plutonium.

8099 (BNWL-tr—263) **Management of high-activity nuclear waste (fission products).** Redon, A.; Mamelle, J.; Chambon, M.; Giraud, B. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 13 Sep 1977. Translation of IAEA-CN-36/226. (CONF-770505—211(trans)). 20p. Dep. NTIS, PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

The problem of high-activity radioactive waste has considerable psychological importance, and the solutions to be applied must have a high degree of safety for a very long period of time. After a review of definitions, the authors define some principles for conditioning fission product solutions by vitrification. The accent is on the characteristics of the product obtained, research and development efforts, and storage conditions (transitory). Finally, the passage to the industrial stage is described.

8100 **Radioactive krypton gas separation.** Martin, J.R. (to Union Carbide Corp.). US Patent 4,045,191. 30 Aug 1977. Filed date 23 Jun 1975. 28p.

Radioactive krypton is separated from a gas mixture comprising nitrogen and traces of carbon dioxide and radioactive krypton by first selective adsorption and then cryogenic distillation of the prepurified gas against nitrogen liquid to produce krypton bottoms concentrate liquid, using the nitrogen gas from the distillation for two step purging of the adsorbent. 6 claims, 8 drawing figures.

8101 **Application of cryogenic distillation to krypton-85 recovery.** Yusa, H.; Kikuchi, M.; Tsuchiya, H. (Hitachi Ltd., Ibaraki (Japan). Hitachi Research Lab.); Kawaguchi, O.; Segawa, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Nucl. Eng. Des.;* **24**: No. 3, 437-441(May 1977).

Fundamental and pilot experiments were carried out to develop a ^{85}Kr recovery system for nuclear power and fuel reprocessing plants. It consisted of a pretreatment unit to remove oxygen (O_2), acetylene (C_2H_2) and nitrogen oxides (NOsub(x)) from the inlet gas, a cyrogenic distillation unit to remove and concentrate ^{85}Kr, and a storage unit for recovered ^{85}Kr.

8102 **Improvements in or relating to the preparation for storage of fission products.** de Bacci, M.; Price, M.S.T. (to UKAEA). British Patent 1,468,233/A/. 23 Mar 1977. 3p.

A method of preparing waste fission products for storage is described that comprises overcoating fission product particles from liquid wastes with a mixture that includes α-SiC, C and a binder, consolidating the overcoated particles, and sintering them in contact with Si to form a matrix of β-SiC enclosing the particles. Details are given of a method for carrying out the process. The fission product particles may be formed from liquid waste fission products by evaporation and calcination, followed by agglomeration of the particles so formed to a size of 0.5 mm to at least 2 mm diameter. The particles may be coated with sealing layers before being overcoated.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 8091, 8098

8103 (ARH-ST—156(Vol.1)) **Evaluation of scintillation probe profiles from 200 area crib monitoring wells. Volume I.** Fecht, K.R.; Last, G.V.; Price, K.R. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-05-2130. 28p. Dep. NTIS, PC A03/MF A01.

Ground disposal of liquid radioactive waste from Hanford separations plants began on a limited basis in 1945. Small volumes of selected radioactive waste were initially discharged to the ground by means of subsurface structures or crib facilities. As more was learned about site geology and waste-sediment interactions, it was concluded that increased volumes of liquid effluent and increased quantities of radionuclides could be safely disposed of in the ground if properly controlled. Waste discharged to the ground was then greatly increased, reaching a peak of 8.34×10^5 Ci discharged in 1955. Thereafter, the volume and quantity of radioactive waste discharge were decreased as ground disposal of radionuclides was minimized and separation plants were shut down. The purpose of this study, as with two earlier studies conducted in 1964 and 1969, is to measure

qualitatively the distribution, redistribution and decay of radionuclides beneath crib facilities. For this study, nearly 300 crib monitoring wells adjacent to approximately 100 crib facilities were logged with a scintillator, a device for measuring radioactivity. The profiles for each well were compared with selected profiles developed between 1954 and 1973. Volume II (Appendix A) and Volume III (Appendix B) contain selected scintillation probe profiles from crib monitoring wells, background information for cribs (waste description, waste inventory and service dates) and an evaluation of radionuclides in the ground, which are listed by crib facility for 200 East Area and 200 West Area, respectively. The distribution, redistribution and decay of radionuclides in the vadose zone are discussed in Volume I.

8104 (ARH-ST—156(Vol.2)) **Evlaluation of scintillation probe profiles from 200 area crib monitoring wells. Volume II.** Fecht, K.R.; Last, G.V.; Price, K.R. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-05-2130. 248p. Dep. NTIS, PC A11/MF A01.

Appendix A presents information on 200 East Area crib monitoring wells and the crib facilities monitored. (LK)

8105 (ARH-ST—156(Vol.3)) **Evaluation of scintillation probe profiles from 200 area crib monitoring wells. Volume III.** Fecht, K.R.; Last, G.V.; Price, K.R. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-05-2130. 231p. Dep. NTIS, PC A11/MF A01.

Appendix B presents information on 200 West Area crib monitoring wells and the crib facilities monitored. (LK)

8106 (IAEA-R—1383-F) **Leaching kinetics of ions from solidified radioactive wastes. Part of a coordinated programme on studies to determine the migration and dispersion of radionuclides from the storage of radioactive wastes under various conditions in the terrestrial environment. Final report for the period 1 October 1971 - 30 November 1976.** Amarantos, S. (International Atomic Energy Agency, Vienna (Austria)). Dec 1976. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A study of the kinetics of leaching of Cs^{+} and Sr^{++} ions from simulated "radioactive wastes" embedded in asphalt or Portland cement is reported. Two types of asphalt (base and emulsified) and of cement (with and without added pozzolanic material) were employed. The elution tests were performed with inactive salts chosen so as to allow study of the same cation in water soluble and sparingly soluble form and mixtures of one soluble and one insoluble salt with a common anion. The object of the work was to study the mechanism of the leaching process (as far as the transport of the ions to the exposed surface of the block is concerned) as well as of any other concurrent processes likely to affect elution kinetics.

8107 (N—77-24924) **Space disposal of nuclear wastes. Volume 1: socio-political aspects.** Laporte, T.; Rochlin, G.I.; Metlay, D.; Windham, P. (University of Southern California, Los Angeles (USA). Dept. of Geological Sciences). Dec 1976. Contract NCA-2-OR-050-603. 252p. (NASA-CR—153219). NTIS PC A12/MF A01.

The history and interpretation of radioactive waste management in the U.S., criteria for choosing from various options for waste disposal, and the impact of nuclear power growth from 1975 to 2000 are discussed. Preconditions for the existence of high level wastes in a form suitable for space disposal are explored. The role of the NASA space shuttle program in the space disposal of nuclear wastes, and the impact on program management, resources and regulation are examined.

8108 (SAND—77-1217) **Chemical analyses of potash-bearing horizons from 21 exploratory holes drilled at a tentative site for the Waste Isolation Pilot Plant, Eddy County, New Mexico.** Griswold, G.B. (ed.). (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 48p. Dep. NTIS, PC A03/MF A01.

Sandia Laboratories drilled 21 potash drill holes over an 18,960-acre site in east-central Eddy County, New Mexico, to evaluate potash resources as part of their Waste Isolation Pilot Plant (WIPP) project. This report furnishes assay information on samples obtained from the drilling program.

8109 (Y/OWI/TM—25) **In situ experiments related to waste repository design.** Fairchild, P.D.; Russell, J.E. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). Aug 1977. Contract W-7405-ENG-26. 25p. (CONF-771102—6). Dep. NTIS, PC A02/MF A01.

From 20. annual AICHE meeting; New York, New York, USA (13 Nov 1977).

The Office of Waste Isolation of Union Carbide Corporation-Nuclear Division has been charged by the U. S. Energy Research and Development Administration with the responsibility to provide deep, land-based repositories in geologic formations for nuclear waste from the commercial fuel cycle. Design and construction of waste repositories require information relative to the behavior of rock under high-temperature and -pressure conditions for long periods of time. Experience has shown that although laboratory data characterizing rock properties are both necessary and useful for preliminary design studies, the behavior of the rock mass ultimately must be determined by in situ tests, preferably carried out at about the same depth and in the same formation horizon as would be used for the waste repository. This paper describes types of relevant in-situ tests.

8110 **Final storage of nuclear fuel waste in rock. What safety level do we want, and what can we attain.** Devell, L. (Aktiebolaget Atomenergi, Studsvik (Sweden)). *Ingenioer-nytt;* **13**: No. 34, 6-9(29 Apr 1977). (In Norwegian).

Proceeding from the imprecise expressions 'completely safe', 'highest conceivable safety level' and 'highest possible safety level', the level of safety of the final disposal of radioactive wastes is discussed. The Scandinavian radiation protection authorities have established guidelines for the long-term collective radiation doses per MW(e)year, and already guidelines are becoming clear covering the whole nuclear power era. Aspects of risk analysis and cost-benefit analysis are also discussed. The concepts 'site multiplicity' and 'technical irreversibility' are introduced. Assuming that wastes are contained in glass, or in spent fuel rods, the potential risk indices as a function of time are presented. In the first 300 years ^{137}Cs and ^{90}Sr dominate. Thereafter ^{241}Am until 3000 years, when ^{243}Am and ^{239}Pu take over. In the long term ^{226}Ra becomes significant also. After 1000 years however, the potential risk is no greater than that of uranium ore, when accessibility becomes the dominant consideration. Factors which could lead to dispersal of the wastes are listed, and finally a rough calculation of the activity reaching a well from leaching of activities from glass in a ground water flow is presented.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 8087, 9016

8111 **Australia and the Fox report.** *Met. Constr. Br. Weld. J.;* 37-39(May 1977).

The outcome of the Ranger Uranium Environmental Enquiry will greatly influence the future development of uranium mining in Australia. The main findings and recommendations of Part I of the report of the enquiry are given, and the worlds uranium milling capacity is summarized.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 8543, 9017

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

8112 (SAND—77-0400) **Structure for the decomposition of safeguards responsibilities.** Dugan, V.L.; Chapman, L.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1977. Contract EY-76-C-04-0789. 19p. (CONF-770656—26). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the Institute of Nuclear Materials Management; Washington, District of Columbia, United States of America (USA) (29 Jun 1977).

A major mission of safeguards is to protect against the use of nuclear materials by adversaries to harm society. A hierarchical structure of safeguards responsibilities and activities to assist in this mission is defined. The structure begins with the definition of international or multi-national safeguards and continues through domestic, regional, and facility safeguards. The facility safeguards is decomposed into physical protection and material control responsibilities. In addition, in-transit safeguards systems are considered. An approach to the definition of performance measures for a set of Generic Adversary Action Sequence Segments (GAASS) is illustrated. These GAASS's begin outside facility boundaries and terminate at some adversary objective which could lead to eventual safeguards risks and societal harm. Societal harm is primarily the result of an adversary who is successful in the theft of special nuclear material or in the sabotage of vital systems which results in the release of material in situ. With the facility safeguards system, GAASS's are defined in terms of authorized and unauthorized adversary access to materials and components, acquisition of material, unauthorized removal of material, and the compromise of vital components. Each GAASS defines a set of "paths" (ordered set of physical protection components) and each component provides one or more physical protection "functions" (detection, assessment, communication, delay, neutralization). Functional performance is then developed based upon component design features, the environmental factors, and the adversary attributes. An example of this decomposition is presented.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 8422

FUSION FUELS

HEALTH AND SAFETY

8113 (ORNL—5171, pp 275-282) **Health physics aspects of fusion power.** Easterly, C.E.; Jacobs, D.G.; Shank, K.E.; Butler, H.M.; Shoup, R.L.; Poston, J.W.; Phillips, J.E.; Otaduy, P.; Booth, R.S.; Wheeler, C.E. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The goal of the health physics aspects of the fusion power program is to provide, on a timely basis, scientific information and technical evaluations on the potential health impacts of fusion power to occupational workers and to members of the public. These items are recognized to be of major importance in the orderly development and public acceptance of a safe controlled thermonuclear reactor (CTR) program. For this reason, a well-diversified, broadly based program has been developed. Most of the work thus far has consisted of critical assessments directed at understanding the potential radiological hazards attendant to fusion power. The primary areas of investigation during the past year have been: data requirements for calculations of localized tritium behavior; tritium instrumentation needs; clothing for protection from exposures to tritium; biological effects of magnetic fields; and metabolic, dosimetric, and environmental data for activation products.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

8114 (K/OA—4038) **Laser cost experience and estimation.** Shofner, F.M.; Hoglund, R.L. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 28 Jun 1977. Contract W-7405-ENG-26. 130p. Dep. NTIS, PC A07/MF A01.

This report addresses the question of estimating the capital and operating costs for LIS (Laser Isotope Separation) lasers, which have performance requirements well beyond the state of mature art. This question is seen with different perspectives by political leaders, ERDA administrators, scientists, and engineers concerned with reducing LIS to economically successful commercial practice, on a timely basis. Accordingly, this report attempts to provide "ballpark" estimators for capital and operating costs and useful design and operating information for lasers based on mature technology, and their LIS analogs. It is written very basically and is intended to respond about equally to the perspectives of administrators, scientists, and engineers. Its major contributions are establishing the current, mature, industrialized laser track record (including capital and operating cost estimators, reliability, types of application, etc.) and, especially, evolution of generalized estimating procedures for capital and operating cost estimators for new laser design.

8115 **Infrared four-wave mixing in liquid CO.** McNair, R.E.; Klein, M.B. (Hughes Research Laboratories, Malibu, California 90265). *Appl. Phys. Lett.;* **31**: No. 11, 750-752(1 Dec 1977).

Four-wave mixing of the type $\omega_4 = 2\omega_1 - \omega_2$ has been observed in pure liquid CO at 77 °K. The CO_2 pump beams were derived from separate resonators to yield a mixing signal at 8.64 μm. The power dependence of the mixing signal has been studied over four orders of magnitude and the nonlinear susceptibility has been measured. Scaling calculations show that efficiencies greater than 10% are expected for pump powers near the breakdown threshold and with confinement of the pump beams in a hollow dielectric waveguide.

RADIATION SOURCES

8116 (SAND—77-0300, pp 61-65) **Pulse neutron generator and control circuits.** Thibideau, F.D. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

This paper describes a neutron generator which was designed and constructed at the request of Sandia Laboratories, Albuquerque, New Mexico. This generator provides a pulsed source of 14 MeV neutrons for use in a prototype uranium logging probe. The neutron generator produces up to 5×10^6 neutrons per pulse at a repetition rate which is variable up to 100 pulses per second. It is packaged in two assemblies, each having a diameter of $2\frac{3}{8}$ inches.

DESIGN AND FABRICATION

REFER ALSO TO CITATION(S) 8867

8117 (SAND—77-0300, pp 66-80) **Characteristics and theory of operation of the controlatron neutron tube.** Volk, R.D. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

The Controlatron (or Type 26E) neutron tube was developed by General Electric under contract to Sandia Laboratories in 1961 to be used in a neutron activation analysis experiment on the lunar surface. It was subsequently employed as a very stable laboratory neutron source for neutron detector calibration within the ERDA complex. The Controlatron is a gas filled neutron tube using a titanium target, Penning type cold cathode ion source, and self-contained reservoir. The general theory of operation of this type of neutron tube utilizing the D-T nuclear reaction is presented.

8118 (SAND—77-0300, pp 81) **Neutron tube fabrication, assembly and processing.** Kubach, R.A. Feb 1977.

From Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment; Albuquerque, New Mexico, USA (24 Feb 1977).

In Seminar proceedings: I. Pulsed neutron uranium borehole logging with prompt fission neutrons (PFN). II. Neutron tube technology for PFN logging equipment.

The fabrication and processing techniques for the Controlatron neutron tube are described herein. Several of the more complex parts made by the hydroform process are described. Purchased parts and materials are noted, along with suppliers. Titanium used for film deposition is discussed to emphasize the need for high purity. Also discussed is the high vacuum processing equipment, which is used for vacuum firing, film deposition, and tube exhaust processing.

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 7899

ISOTOPIC POWER SUPPLIES

REFER ALSO TO CITATION(S) 9036

8119 (ORNL—5171, pp 94-95) **Nuclear-powered pacemaker fuel cladding study.** Shoup, R.L. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The composite of metals and alloys used in the fabrication of ^{238}Pu cardiac pacemaker fuel capsules resists the effects of high temperatures, high mechanical forces, and chemical corrosives and provides more than adequate protection to the fuel pellet even from deliberate attempts to dissolve the cladding in inorganic acids. This does not imply that opening a pacemaker fuel capsule by inorganic acids is impossible but that it would not be a wise choice.

DESIGN AND FABRICATION

8120 (PB—268221) **Vapor cycle energy system for implantable circulatory assist devices. Final summary May—Oct 1976.** Watelet, R.P.; Ruggles, A.E.; Hagen, K.G. (Thermo Electron Corp., Waltham, Mass. (USA)). Mar 1977. Contract N01-HV-4-2909. 68p. NTIS PC A04/MF A01.

The report describes the development status of a heart assist system driven by a nuclear-fueled, electronically controlled vapor cycle engine termed the tidal regenerator engine (TRE). The TRE pressurization is controlled by a torque motor coupled to a displacer. The electrical power for the sensor, electronic logic and actuator is provided by thermoelectric modules interposed between the engine superheater and boiler. The TRE is direct-coupled to an assist blood pump which also acts as a blood-cooled heat exchanger, pressure-volume trasformer and sensor for the electronic logic. Engine cycle efficiency in excess of 14% has been demonstrated routinely. Overall system efficiency on 33 watts of over 9% has been demonstrated (implied 13% engine cycle efficiency). A binary version of this engine in the annular configuration is now being tested. The prelimi-

nary tests demonstrated 10% cycle efficiency on the first buildup which ran well and started easily.

HYDROGEN

8121 (PB—268468) **Hydrogen economy: a preliminary technology assessment. Executive summary.** Dickson, E.M.; Ryan, J.W.; Smulyan, M.H. (Stanford Research Inst., Menlo Park, Calif. (USA)). Feb 1976. 16p. NTIS PC A02/MF A01.

Hydrogen must be manufactured from basic energy resources since it is not a naturally occurring energy form. This Executive Summary addresses the question of the feasibility of the use of hydrogen as a fuel. Although it is generally believed that hydrogen might soon become less expensive than petroleum, competition among fuels in the energy marketplace and the need to derive hydrogen from other energy sources will insure that hydrogen does not become less expensive than alternatives for a very long time. Transitions involving change in basic infrastructure technologies, systems, and institutions are difficult to effect because new, embryonic systems must compete with established systems, often at a price disadvantage. This report summarizes: (1) prospects for a hydrogen economy; (2) hydrogen production and handling; (3) transition to a hydrogen economy; (4) consequences of a hydrogen economy; (5) policy implications for the Federal Government; and (6) recommended government hydrogen RandD priorities.

PRODUCTION

REFER ALSO TO CITATION(S) 7831

THERMOCHEMICAL PROCESSES

8122 **Process for the preparation of hydrogen.** duPont, A.A. US Patent 4,045,546. 30 Aug 1977. Filed date 6 Aug 1976. 6p.

Hydrogen is produced from water by the addition of heat to a series of chemical reactions which comprise the reaction of cadmium with water, and the subsequent recovery of the cadmium for re-use. The equipment used to produce the hydrogen requires only the input of water and heat to produce an output of hydrogen and oxygen gas.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 8598, 8759, 8760, 8761

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 8611

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 7837, 8761, 8949, 9104, 9105

PROPERTIES

REFER ALSO TO CITATION(S) 8598

8123 **Saturated platelets are new intermediates in hydrocarbon pyrolysis and carbon formation.** Abrahamson, J. *Nature (London);* **266**: No. 5600, 323-327(24 Mar 1977).

An important problem in flames and in the industrial pyrolysis of hydrocarbons is the understanding of how solid carbon is formed either in the gas phase (soot) or on surrounding surfaces. The article proposes a single route to soot for all conditions, passing through sequential chemical and physical steps. Formation of solid carbon during pyrolysis of gaseous hydrocarbons may involve saturated platelet intermediates which retain the H-C ratio of acetylene and contain carbon bonded by single bonds except at their edges. In the heating of cokes, acetylene formed from residual hydrogen can redeposit from the pore spaces as platelets.

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 7814

8124 **Methanation studies on nickel-aluminum flame-sprayed catalysts.** Baird, M.J.; Steffgen, F.W. (US ERDA, Pittsburgh Energy Res Cent, Pa). *Ind. Eng. Chem., Prod. Res. Dev.;* **16**: No. 2, 142-147(Jun 1977).

Methanation catalysts were prepared by flame-spraying aluminum onto a nickel surface followed by heating to form a Raney-type alloy and then activating with a caustic leach. Different alloying temperatures from 400 to 950 C were employed. A maximum in methanation activity occurred for a sample alloyed at 725$degree$C. Little alloying occurred for catalysts preheated at 400 C whether for 1 h or for 9 10 h and low activities were obtained. This indicates that active catalysts were not formed by a slow diffusion process at a temperature that might be used for methanation. It is shown that alloying takes place very quickly near or above the melting point of aluminum and that no more than 10 min is required for the heating process. Methanation activity and product selectivity were determined using a pulse microreactor by passing 3:1 synthesis gas over each sample at temperatures ranging from 300 to 400 C. For all catalysts, the conversion of CO increased with increasing reactor temperature. 11 refs.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 8191, 8715

8125 **Differential speed two roll mill pretreatment of cellulosic materials for enzymatic hydrolysis.** Tassinari, T.; Macy, C. (U.S. Army Natick Research and Development Command, MA). *Biotechnol. Bioeng.;* **19**: No. 9, 1321-1330(Sep 1977).

Differential speed two roll milling is an effective pretreatment for increasing the susceptibility of cellulose to enzymatic hydrolysis. Using mills with three, six, and ten in. diam rolls and processing times of 10 min or less results in the following percent increases in susceptibility over untreated controls: cotton, 1100; maple chips, 1600; white pine chips, 600; newspaper, 125. In comparison, ball milling of newspaper for 24 hr gives only a 62 percent increase. A further advantage of the roll mill is the increased wet density of the product permitting higher slurry concentrations during hydrolysis. Important parameters of mill effectiveness are roll clearance and processing time.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 8762

PROPERTIES

REFER ALSO TO CITATION(S) 8598

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 7841

PREPARATION FROM WASTES OR BIOMASS

8126 **Rapid ethanol fermentations using vacuum and cell recycle.** Cysewski, G.R.; Wilke, C.R. (Univ. of California, Berkeley). *Biotechnol. Bioeng.;* **19**: No. 8, 1125-1143(Aug 1977).

Cell recycle and vacuum fermentation systems were developed for continuous ethanol production. Cell recycle was employed in both atmospheric pressure and vacuum fermentations to achieve high cell densities and rapid ethanol fermentation rates. Studies were conducted with Saccharomyces cerevisiae (ATCC No. 4126) at a fermentation temperature of 35°C. Employing a 10 percent glucose feed, a cell density of 50 g dry wt/liter was obtained in atmospheric-cell recycle fermentations which produced a fermentor ethanol productivity of 29.0 g/liter-hr. The vacuum fermentor eliminated ethanol inhibition by boiling away ethanol from the fermenting beer as it was formed. This permitted the rapid and complete fermentation of concentrated sugar solutions. At a total pressure of 50 mmHg and using a 33° percent glucose feed, ethanol productivities of 82 and 40 g/liter-hr were achieved with the vacuum system with and without cell recycle, respectively. Fermentor ethanol productivities were thus increased as much as twelvefold over conventional con-

tinuous fermentations. In order to maintain a viable yeast culture in the vacuum fermentor, a bleed of fermented broth had to be continuously withdrawn to remove nonvolatile compounds. It was also necessary to sparge the vacuum fermentor with pure oxygen to satisfy the trace oxygen requirement of the fermenting yeast.

8127 Cellobiase from Trichoderma viride: purification, properties, kinetics, and mechanism. Gong, C.S.; Ladisch, M.R.; Tsao, G.T. (Purdue Univ., West Lafayette, IN). *Biotechnol. Bioeng.;* **19**: No. 7, 959-981(Jul 1977).

Three distinct cellobiase components were isolated from a commercial Trichoderma viride cellulase preparation by repeated chromatography on DEAE cellulose eluting by a salt gradient. The purified cellobiase preparations were evaluated for physical properties, kinetics, and mechanism. Results from this work include: (1) development of a one step enzyme purification procedure using DEAE-cellulose; (2) isolation of three chromatographically distinct, yet kinetically similar, cellobiase fractions of molecular weight of approximately 76,000; (3) determination of kinetics which shows that cellobiase hydrolyzes cellobiose by a noncompetitive mechanism and that the product, glucose, inhibits the enzyme, and (4) development of an equation, based on the mechanism of cellobiase action, which accurately predicts the time course of cellobiose hydrolysis over an eightfold range of substrate concentration and conversions of up to 90 percent. Based on the data presented in the paper, it is shown that product inhibition of cellobiase significantly retards the rate of cellobiose hydrolysis.

8128 Adsorption of trichoderma cellulase on cellulose. *Biotechnol. Bioeng.;* **19**: No. 7, 1091-1094(Jul 1977).

The first step in the enzymatic hydrolysis of cellulose is the adsorption of the enzymes on the surface of the cellulose fiber. A more detailed understanding of the process might give new insights into the mechanisms of enzymatic hydrolysis. Results are presented showing the effect of pH (3.8 to 5.3) and temperature (20 to 50°C) on the adsorption of Trichoderma cellulase on three different preparations of pure cellulose: cellulose pulp, milled pulp, and microcrystalline cellulose.

8129 Computation of the fraction of induced cells in enzyme induction systems. Von Stockar, U.; Yang, R.D.; Wilke, C.R. (Univ. of California, Berkeley). *Biotechnol. Bioeng.;* **19**: No. 4, 445-458(Apr 1977).

A theoretical model is developed for continuous multistage enzyme production systems, which consist of a growth fermentor used for growing microorganisms rapidly without enzyme production and a subsequent system of induction reactors in which enzyme induction and production occurs. The model allows the computation of the fraction of induced cells residing in the induction reactors for organisms exhibiting a lag phase in enzyme induction. For this model a general analytical solution was obtained for the cumulative internal residence time distribution of a series of n well-stirred vessels with a recycle. The theoretical results are compared in a preliminary way with experimentally measured cellulase productivities of continuous multistage cellulose fermentations with Trichoderma viride QM 9414.

PREPARATION

REFER ALSO TO CITATION(S) 7831

GASEOUS WASTE FUELS

REFER ALSO TO CITATION(S) 8948

HYDRO ENERGY

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 8544

8130 Integrated powerhouse for Manitoba's limestone project. Bateman, L.A. (Manitoba Hydro Electric Board, Winnipeg, CA); Hopper, H.R. *Eng. J. (Montreal);* **60**: No. 5, 33-36(1977).

Increasing costs resulting from higher interest rates and inflation forced Manitoba Hydro to look for more economical means of developing hydro plants. Detailed studies were performed to assess the potential savings and construction problems involved in integrating the spillway with the powerhouse of a hydroelectric development.

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 8130

SOLAR ENERGY

REFER ALSO TO CITATION(S) 8231, 8611

8131 (ORO/5278—2) **Proceedings of the National Solar Energy Workshop of the ERDA Division of Solar Energy and the state energy offices.** (Alabama Univ., Huntsville (USA). Center for Environmental and Energy Studies). 1976. Contract EY-76-S-05-5278. 361p. Dep. NTIS, PC A16/MF A01.

Proceedings are presented of a workshop to bring together members of the ERDA Division of Solar Energy and energy officials of the various states to help improve the exchange of information and stimulate more direct participation in the planning of national solar energy research, development, demonstration and commercialization programs. The workshop was organized into six sessions with participants attending seven workshops involving meteorological and solar heating and cooling demonstration programs. Also, "mini-regional" meetings were held, as well as review and detailed presentation sessions. Topics ranged from measurement and construction standards to commercialization prospects for solar energy; and from the national data collection, evaluation and dissemination program to states participating in the design and collection of solar radiation data networks. The seven working groups were organized to allow each participant to attend sessions on three different topics of their choice. The subject areas were: (1) state participation in meteorological network design: data collection; (2) radiation instrumentation measurements and calibration; (3) meteorological data management (standards and format); (4) state participation in solar heating and cooling demonstration; (5) heating and cooling standards and criteria; (6) solar heating and cooling data management system; and (7) solar heating and cooling systems analysis. Theedited and consolidated results of all workshop sessions, handouts, and summaries are presents. (WHK)

8132 Sun power. An introduction to the applications of solar energy. McVeigh, J.C. New York; Pergamon Press Inc. (1977). 216p.

The following chapters are included: historical background; solar radiation; water and air heating applications; space heating applications; thermal power and other thermal applications; methods of economic analysis; photovoltaic cells, biological conversion systems, and photochemistry; wind power; and some practical heating applications. A glossary is also included. (MHR)

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 8210, 8613

8133 (AED-Conf—76-521-001) **Meteorological data for solar energy applications.** Valko, P. (Swiss Meteorological Inst., Zurich). 1976. 52p. (In German). (CONF-7610108—1). Dep. NTIS (US Sales Only), PC A04/MF A01.

From Symposium of the German Solar Energy Society; Stuttgart, German, Federal Republic of (F.R. Germany) (22 Oct 1976).

For planning, simulation and testing of solar energy plants, data on solar radiation and other meteorological quantities are necessary. This information is gained statistically by using many years of records and by immediate in situ measurements made simultaneously with measuring the energy output of the system. Frequency distributions of single elements and combined distributions of two and more elements respectively may be considered as meteorological design information. This should be computed for many places for different seasons and different hours of the day. Missing data have to be estimated by applying theoretical models or empirical methods. For testing of solar energy plants a mobile system of radiation measuring devices is presented. By this system interesting results were achieved on the diffuse irradiation of inclined planes.

8134 (CONF-770112—, pp 378-390) **Solar radiation and weather data base preparation.** Randall, C.M. (Aerospace Corp., Los Angeles). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The objective of the project described is to provide a reliable, broadly based, hourly meteorological and solar radiation data base

including both direct and total insolation values for use in solar energy systems analyses. Meteorological and solar radiation data commonly available today and which cover significant time periods almost exclusively come from the National Weather Service. For systems analysis purposes, these data suffer from two problems: A lack of direct-normal insolation values, and poor reliability of the total-hemispheric insolation values due to a number of problems. Figure 1 summarizes the differences between the two types of insolation observations. The National Climatic Center, with ERDA sponsorship, is completing a rehabilitation of the existing hourly solar insolation data for about 26 stations in the contiguous 48 states and covering the time from about 1952 to 1975. For many solar energy studies the direct-normal insolation is also required, and must be estimated since routinely measured values covering long time periods are, in general, unavailable. The availability of the improved total hemispheric data makes a collateral improvement in the direct-normal estimating procedure and the production of new complete data bases attractive at this time. The project described consists of two tasks: (a) develop an improved direct-normal insolation estimating procedure; and (b) employ this algorithm to produce improved hourly insolation and meteorological data bases from the rehabilitated NWS data.

8135 (CONF-7608108—1) **First results obtained from the Swiss mobile system for solar radiation measurements.** Heimo, A.; Valko, P. (Swiss Meteorological Inst., Zurich). Oct 1976. 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From UNESCO/WMO solar energy symposium; Geneva, Switzerland (30 Aug 1976).

An autocar, equipped with a number of different radiation measuring instruments, constructed at the Physical-Meteorological Observatory of Davos, was operated at various locations during the last two years. By using 7 pyranometers movable with step-motors in any position this mobile system permits to determine the global radiation as falling on arbitrarily orientated and inclined plane surfaces. The direct solar radiation on normal surface is measured in the total spectrum, in the 3 broad spectral ranges of the Schott filters OG1, RG2 and RG8 and also at 12 quasi-monochromatic wavelengths. Terrain properties and cloudiness distribution are recorded by a 180° (fish-eye) camera. By these means also the diffuse radiation flux on 77 differently orientated and tilted planes could be determined in several hundred cases for each plane. The dependence of the global and diffuse radiation intensities on solar height, atmospheric turbidity, cloudiness and on the orientation and inclination of the plane are discussed. The system is among others appropriate for extensive and precise calibration of solar collectors immediately at the site of their installation.

8136 (SAND—77-1521C) **Average solar radiation available to various collector types.** Boes, E.; Anderson, H.; Hall, I.; Prairie, R.; Stromberg, R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 10p. (CONF-770953—2). Dep. NTIS, PC A02/MF A01.

From Concentrating solar collector conference; Atlanta, Georgia, USA (26 Sep 1977).

The results of a recently completed analysis of the seasonal and geographic distributions of solar radiation available to various types of solar collectors in the U.S.A. are given. The results are presented in the form of tables of seasonal mean daily amounts of solar radiation available to various configurations for tracking surfaces and to a comprehensive set of fixed surface orientations for 26 U.S. sites based on data for the years 1958-1962. All solar radiation availabilities described are separated into direct and diffuse components so that they are applicable for both concentrating and flat-plate collectors. Also, some comparisons of the relative amounts of solar energy available to different solar collector schemes are presented. A primary conclusion of the study is that there is generally more direct solar radiation available to tracking, concentrating collectors than there is total radiation available to fixed, flat-plate collectors.

ECONOMICS

REFER ALSO TO CITATION(S) 8184, 8214, 8218

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 8208, 8213, 8214

8137 (DSE/2523—2) **Public utility and solar energy interface: as assessment of policy options. Final report.** Feldman, S.L.; Anderson, B. (Clark Univ., Worcester, Mass. (USA); Total Environmental Action, Inc., Harrisville, N.H. (USA)). 31 Dec 1976. Contract EX-76-S-01-2523. 206p. Dep. NTIS, PC A14/MF A01.

Previous research studies have for the most part failed to consider the interaction of solar energy heating/cooling/hot water systems with the provision for auxiliary systems. This study reviews, assesses, and critiques existing research and on-going activity in the interface between the public utility industry and solar energy systems for buildings. This study also suggests and determines the potential impact of policy operations in the interface. The specific objectives are: (1) identify and assess the range of technology options that are commercially feasible with respect to the utility/solar interface; (2) identify current trends in the solar energy market, including a regional assessment of the critical factors in solar energy system adoption with regard to the utility/solar interface; (3) identify the problem areas and respective remedial options associated with the utility/solar interface with particular emphasis on legal, rate-making, statutory, and attitude-conveyance vehicles; and (4) determine the range of impacts of policy options in the interface on adoption rates and construction types of solar energy buildings.

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 8194, 8196, 8200, 8224

8138 (CONF-770112—) **Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.** (California Univ., San Diego (USA)). 1977. Contract EG-77-S-03-1432. 708p. Dep. NTIS, PC A99/MF A01.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

Each paper was separately processed for the Energy Data Base. (DG)

8139 (CONF-770112—, pp 312-335) **Mission analysis of photovoltaic solar energy systems.** Leonard, S.L. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The overall objective of the project described is to support the formulation, planning, and justification of the ERDA National Photovoltaic Plan through (a) analyses that lead to the identification of promising terrestrial applications for photovoltaic solar energy conversion, to the recognition of attractive demonstration possibilities, and to the identification and resolution of critical external issues influencing the widespread utilization of the technology and (b) planning support to refine the overall program strategy. Previous activities and current efforts are summarized.

8140 (CONF-770112—, pp 391-399) **Systems engineering and analysis task.** Marshall, B.W.; Schueler, D.G. (Sandia Labs., Albuquerque, NM). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The Systems Engineering and Analysis Task of the Photovoltaic Systems Definition Project at Sandia Laboratories is concerned with providing system analysis and definition for the ERDA National Solar Photovoltaic Program. The task has as its objectives providing conceptual design studies, conducting detailed analyses and design tradeoff studies, performing subsystem analysis and design requirements, providing systems definition support for tests and experiments and conducting component and subsystem integration experiments. During the past six months, primary emphasis has been placed on concluding the existing conceptual design studies, providing an updated, thorough solar data base, and developing in-house system simulation and optimization models. During the next six months, these efforts will be continued. In particular, solar data tapes, maps, and tables will be available and a report presenting a comprehensive comparison of the final results of the conceptual design studies will be published along with the final reports from each of the contractors. A substantial amount of new systems analysis and design studies is planned for the next six months. These studies will support the test and demonstration projects, will provide applications analysis and baseline design definition, and will provide subsystem performance requirements and technology status support. Examples of the studies planned are: (1) assessment of the utility/customer interface for on-site systems, (2) conceptual design of photovoltaic/thermal electric systems, (3) reliability and capacity displacement for PV systems in a utility grid, (4) transient effects and reliability of photovoltaic array systems, (5) and power conditioning studies. Other areas of study are listed.

8141 (CONF-770112—, pp 400-407) **System analysis and STF interface.** Watkins, J.L. (Sandia Labs., Albuquerque, NM): Forestieri, A.F. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Sandia Laboratories has responsibility for the Systems Definition Project within the National Photovoltaic Conversion Program. As a part of this activity, Sandia is expected to provide conceptual systems designs and evolve preferred system configurations and preliminary design specifications for various applications. Many system performance characteristics can be determined by developing analytical models of the system components. However, there naturally arise many questions concerning the performance of terrestrial photovoltaic systems that can best be answered with the aid of actual test results. A variety of these system questions that have surfaced in the system analysis and design studies are presented and approaches to determining the answers to these questions using the System Test Facility are discussed. In addition, consideration is given to future areas of systems studies that may become apparent in the course of experimental activity at the System Test Facility.

8142 (CONF-770112—, pp 558-578) **Progress and plans for the ERDA tests and applications project.** Palmer, R.S. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The Tests and Applications Project is one of several interrelated projects making up the ERDA National Photovoltaic Conversion Program. Objectives of the Tests and Applications Project are to conduct tests, demonstrations, and evaluations of photovoltaic systems and subsystems in a variety of terrestrial applications. Experience and information gained through this project will be used to evaluate emerging systems technology, provide systems-related guidance to the other projects of the national program, and develop information for future photovoltaic program planning. During the past six months, project efforts have emphasized completing processing of modules from the JPL 46 KW procurement into applications as well as planning and conducting a second workshop related to solar cell measurement procedures. Other efforts have included installation of additional solar cell modules in the ERDA Photovoltaic System Test Facility at LeRC which is now operational at a nominal 10 kW capacity, and final site preparation for expansion to 40 kW. In addition, organizational changes to the Project were completed to strengthen the focus on application efforts and integrate with a newly formed Energy Programs Directorate at Lewis. Also, continued support was given to the ERDA Photovoltaic Systems Planning Group activities. Project-to-project interfacing has continued with JPL, Sandia and DoD on a variety of topics related to modules, applications planning, and system design and support. Specific activities in each of the major subprojects are described.

8143 (CONF-770112—, pp 579-595) **MIT/LL solar photovoltaic field tests and applications project.** Matlin, R.W. (MIT Lincoln Lab., Lexington, MA). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The purposes of the Solar Photovoltaic Field Tests and Applications (FT and A) Project are to: establish technical credibility of solar photovoltaic (PV) energy systems; identify and eliminate technical and institutional constraints to their widespread acceptance; provide data for economic modelling of solar PV systems; and reinforce the national goals as delineated in the ERDA Photovoltaic Program Plan. From this it is seen that the principal role of the FT and A project is the acquisition of data in the broadest sense--technical, institutional, and economic--from a spectrum of applications and operating situations. This activity will be pursued over a broad range of applications in the various demand sectors: Agriculture, Industry, Service/Commercial/Institutional, Residential, Transportation, and Foreign/LDC. An additional application area not based on demand categorization will also be pursued, namely, Central Power. It should be noted that the term Field Tests and Applications bears a special connotation and is distinctly different from Demonstration, which is a later phase concerned mainly with showing market readiness. The project objectives are described in two areas, one associated with development of plans and the other with fielding of experimental photovoltaic systems.

8144 (CONF-770112—, pp 596-616) **MIT/LL residential program.** Sacco, S.B. (MIT Lincoln Lab., Lexington, MA). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The objectives of the MIT/LL residential program are to develop and demonstrate the technology of photovoltaic power systems as utilized in residential applications and to develop the institutional interfaces (i.e. financial, insurance, building codes) necessary to permit residential applications of photovoltaics to achieve market penetration as rapidly as possible after the attainment of economic viability, in this market sector. To accomplish these objectives a seven-year program has been proposed which will field a total of 57 residential units in the classifications of mobile, single family, and multi-family. These are spread in a pattern of increasing rate of construction over the seven-year period and will be located in areas which have been determined to be probable areas of early economic viability for residential photovoltaics. For the FY 77 segment of this plan, it is planned to design and construct three residences, all of which will be of single family detached construction. Two of these will be of the "stand-alone" variety (i.e. no connection to utility grid) and will be sited in northeastern and southwestern locations in the U.S. The third residence will be a two-way interactive design which supplies power to the electric power grid during periods of high insolation and draws power from the grid whenever the load is greater than the output from the solar array. This residence will most likely be sited in southeastern U.S.

8145 (CONF-770112—, pp 617-686) **Military applications of photovoltaic systems.** Faehn, D.D. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The principal objective of the Military Applications of Photovoltaic Systems (MAPS) program is to investigate the applicability of solar photovoltaic energy conversion systems to a wide variety of military power consuming equipment. This is to be accomplished by a comprehensive demonstration program, involving six DOD systems with a total array peak power rating of approximately 90kW. Five of these projects were scheduled for implementation in FY76. Initially, the smaller demonstration projects were to be operated at a centralized location (Fort Belvoir, Virginia), after which they are to be evaluated under more representative military environments. The outcome of this demonstration program is expected to facilitate the early introduction of solar cell power systems to the anticipated substantial market within DOD. Wide exposure of the attributes and military potential of photovoltaic energy systems and early identification and solution of technology problem areas will minimize the time period required for research, development, and acquisition of these systems.

8146 (CONF-770112—, pp 20-37) **Solar cell and array manufacturing processes.** Williams, B.F. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Silicon solar cell array fabrication techniques and cost data are presented. (DG)

8147 (CONF-770112—, pp 38-57) **Automated array assembly assessment.** Coleman, M. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Cost data are presented for various solar cell array fabrication processes. (DG)

8148 (CONF-770112—, pp 58-67) **Uniform costing methodology for manufacturing processes.** Chamberlain, R.G. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Cost data are presented for manufacturing processes related to the production of silicon solar cell arrays. (DG)

8149 (CONF-770112—, pp 68-72) **Price goal allocations.** Macomber, H.L. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Silicon solar cell array fabrication cost data are presented. (DG)

8150 (CONF-770112—, pp 73-80) **Concentrator development task of the ERDA photovoltaic systems definition project.** Burgess, E.L.; Schueler, D.G. (Sandia Labs., Albuquerque, NM). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

An approach to photovoltaic-concentrator development is to investigate both basic performance of system components as well as

system-level considerations. Solar cells which have high power conversion efficiencies at high sunlight intensity and elevated temperature are being studied. Both single crystal silicon and single crystal gallium arsenide solar cell technologies are being developed and evaluated. The cost and performance of a variety of concentrator technologies is being studied, as well as solar cell cooling methods and the potential of combined electrical and thermal conversion total energy systems. Several prototype concentrator arrays having peak output in the 100 We to 1 kWe range are currently being constructed for performance evaluation.

8151 (CONF-770112—, pp 81-107) **Fundamental considerations for high-efficiency silicon p—n junction solar cells.** Lindholm, F.A.; Sah, C.T.; Fossum, J.G. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The purpose of the paper is to describe several considerations relevant to the design of silicon p-n-junction solar cells that have resulted from recent studies of basic mechanisms influencing efficiency for terrestrial applications.

8152 (CONF-770112—, pp 108-121) **GaAlAs concentrator cells. High performance GaAs photovoltaic cells for concentrator applications.** Knechtli, R.C. (Hughes Research Labs., Malibu, CA). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The objectives of the program described are to exploit the capabilities of (AlGa)As-GaAs solar cells for high efficiency performance at high concentration ratios. One leading program objective is to adapt to the reproducible and economically viable fabrication of concentration cells the technology which has been developed for the successful fabrication of large area high efficiency (AlGa)As-GaAs solar cells for space applications.

8153 (CONF-770112—, pp 122-132) **High performance GaAs photovoltaic cells for concentrator applications.** James, L.W. (Corporate Solid State Lab., Palo Alto, CA). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

GaAs/AlGaAs concentrator solar cells have already successfully shown scientific feasibility for very efficient photovoltaic terrestrial power generation. The work described has two broad objectives: demonstration of an even higher level of performance, and progress towards the demonstration of economic and manufacturing feasibility.

8154 (CONF-770112—, pp 133-149) **Silicon solar cell development for concentrator applications.** Fossum, J.G.; Burgess, E.L. (Sandia Labs., Albuquerque, NM). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The objective of the work described is to optimize the design of, and to develop the fabrication process for single-crystal silicon solar cells for applications at illumination levels up to approximately 100 suns and operating temperatures up to approximately 100°C. The technology developed will provide the basis for large-scale production of high-intensity silicon solar cells by commercial cell manufacturers.

8155 (CONF-770112—, pp 150-164) **High concentration silicon solar cells photovoltaic concentrator arrays.** Napoli, L.S. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The overall objective of the project is to design, fabricate, and test photovoltaic concentrator arrays with the purpose of reducing the cost of terrestrial photovoltaic power generation. Two 100 watt and two 300 watt, fully operational, passively cooled photovoltaic concentrator arrays are to be delivered under this contract. An analytical evaluation of the production cost of such photovoltaic arrays will be made as a function of production quantity in the 10 KW to 10 MW electrical power output range. The paper deals with the design, fabrication, and evaluation of the solar cells to be used in the concentrator arrays. The two 100 watt arrays have been constructed and delivered. The solar cells for these two arrays were fabricated from six 2-inch diameter silicon wafers.

8156 (CONF-770112—, pp 165-176) **Status report on an interdigitated back contact solar cell.** Schwartz, R.J. (Purdue Univ., West Lafayette, IN). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The purpose of the project described is to design, fabricate, test, and deliver interdigitated back contact silicon (IBC) solar cells which are to be used in concentrated sunlight. Specifically, the goals of the project are to perform analytic design studies and optimization of IBC cells with a range of illumination intensities varying from .1 to 50 w/cm² and for spectral distributions from AM 1 to AM 2. Effects of non-uniform illumination, off-normal incidence illumination, and chromatic aberation are also to be included in the analytic studies.

8157 (CONF-770112—, pp 177-186) **Terrestrial photovoltaic power systems with sunlight concentration.** Backus, C.E.; Jacobson, D.L.; Wood, B.D. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The objective of the program during the last three years was to generate and evaluate information on all aspects of photovoltaic concentration systems. During 1976 ASU has been experimentally testing cells and other components that were especially made for concentration systems. Several silicon cells especially designed for concentration by Spectrolab were tested in concentrated sunlight up to about 60 suns. For constant temperature operation all of these cells showed an increase in efficiency up to about 10 to 15 suns and then a gradual decrease as the intensity continued to increase.

8158 (CONF-770112—, pp 186-199) **Solar cells for compound parabolic concentrators. Application of the compound parabolic concentrator to solar photovoltaic conversion.** McIntire, W.R. (Argonne National Lab., IL). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Studies are described of the use of compound parabolic concentrators (CPC's) with photovoltaic cells. Two panels comparable in size to the flat panels produced under Jet Propulsion Laboratory procurements have been designed and constructed. The panels require monthly north-south adjustments but are nontracking. One panel uses hollow, aluminized CPC's, and the other uses Dielectric CPC's—solid acrylic bars with the CPC shape which use a total internal reflection (TIR) to concentrate sunlight on photovoltaic cells optically bonded to their exit apertures. In addition to the advantage of TIR (no losses upon reflection), the DCPC units have a greater acceptance angle due to refraction at the entrance surface. This may be traded for shorter concentrators or for a concentration ratio increase of approximately 1.5. The DCPC panel was tested at Argonne before delivery to Sandia. The peak power output was 114 watts in a 900 w/m² sun. For 1.0 kw/m² direct insolation, the test data would scale to 138 watts. The design of photovoltaic cells for use with the CPC's is covered in the balance of the paper. The basic concentrator shape is that of two overlapping parabolas.

8159 (CONF-770112—, pp 200-205) **Overview.** Brandhorst, H. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The role of NASA-LeRC in meeting the objectives of the ERDA photovoltaic program are listed, and progress in the program is summarized. (DG)

8160 (CONF-770112—, pp 206-215) **Visual defects in 46 kW modules.** Weinberg, I. (Lewis Research Center, Cleveland, OH). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

All of the modules scheduled for delivery to NASA-LeRC, approximatey 44 KW, from the JPL 46 KW buy, have been delivered for inspection and processing into photovoltaic applications. Approximately twelve percent of the received modules have been processed through the Lewis Pulsed Xenon Simulator where I-V curves were obtained under standard conditions (air mass one, 28°C). In addition visual inspections were performed on the modules before assembly into arrays for use in applications. The major defects observed in the visual inspection include air bubbles in the encapsulant, pinholes, and protrusions through the encapsulant. A breakdown, by supplier, is given for these and additional types of defects. Most of the visual defects observed are of the type that do not impair module performance. The remainder are such that they are easily repairable. In addition to inspection, before use, modules

are visually inspected at NASA-LeRC, while in use in the ERDA/LeRC Systems Test Facility. The major types of defects observed in the STF are delamination, partial cell darkening and dirt accumulation. The first two are irreversible defects while dirt accumulation can be removed by cleaning with detergent solution. I-V measurements were obtained for modules, both before and after cleaning, on removal from the facility. The results indicate that cleaning can effectively assist in maintaining the power output of modules of the type tested.

8161 (CONF-770112—, pp 216-221) **JPL accelerated/abbreviated test program.** Carroll, W.F. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Objectives and results of the JPL photovoltaic system encapsulation test program are described. (DG)

8162 (CONF-770112—, pp 222-230) **Results of outdoor real time and accelerated testing.** Forestieri, A.F. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Real time and accelerated outdoor testing was performed on a variety of samples of interest to the ERDA National Solar Photovoltaic Program. The real time tests were performed at seven different sites and the accelerated tests were performed at one of these sites in southwestern United States. The samples tested were of three different types. Transmission samples were made from the materials under test and the optical transmission was measured before and after exposure to determine changes in transmission. Solar cell/Test material samples were prepared by attaching the materials under test to solar cells. Solar cell characteristics before and after exposure were used to determine any effect on the test material. Finally, solar cell modules, as produced by the manufacturers for the ERDA/JPL 46 kW buy, were also exposed. Fourteen different materials, selected as possible solar cell covers, and one adhesive were tested. Four possible substrate materials were also tested. A total of 478 different samples were tested. Some of these are still being exposed and only qualitative results are available from them.

8163 (CONF-770112—, pp 231-249) **46 kW module performance.** Curtis, H.B.; Weinberg, I. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

During the past eight months, over 6000 modules have been delivered to NASA-Lewis from the 46 kW ERDA buy. These modules range in power from about 5 to 15 watts and in area from about 800 to 2300 cm^2. I-V measurements have been performed on several hundred modules chosen on a random basis throughout the delivery schedule. The purpose of the paper is to show the results of these I-V measurements in the form of distributions of short-circuit current, open-circuit voltage and maximum power for each of the four manufacturers. All the I-V measurements were made using a xenon pulsed solar simulator. Data were taken at room temperature and at an irradiance level near 100 mW/cm^2 and then converted to the standard conditions of 28°C and 100 mW/cm^2. For each manufacturer, a calibrated reference cell, matched in spectral response to the module being measured, was used to determine incident irradiance. The data are presented in the form of histograms for short-circuit current, open-circuit voltage and maximum power for each manufacturer. On each histogram a normal distribution curve is plotted. In all cases, the data are normalized so that the average value is equal to one. A table showing standard deviations in percent for all distributions is included. There were no noticeable trends in any of the data throughout the delivery schedule.

8164 (CONF-770112—, pp 250-259) **Matching of reference cells to modules under test.** Weizer, V.G. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Variations in the terrestrial solar spectrum caused by changing atmospheric conditions place severe restrictions on the procedures used in measuring the power output of photovoltaic modules and arrays. A considerable simplification of the testing procedure can be effected, however, by requiring a close match between the spectral response of the reference cell and that of the test cell or array. To be spectrally matched, two devices must have spectral response curves that are in the same proportion to each other over their entire wavelength range. Unfortunately, because of size restrictions, conventional spectral response measurement techniques cannot be used when large area arrays are to be matched. An alternate approach involves the use of a large area solar simulator and a pair of broad band optical filters. The filters are chosen so as to sample both the red and the blue ends of the solar spectrum. The measurement procedure consists of the determination of device output under both red and blue filtered conditions. The ratio of the short-circuit current under red illumination to that under blue illumination, termed the red/blue ratio, is then used to characterize the cell or array spectrally.

8165 (CONF-770112—, pp 260-268) **Interlaboratory comparison measurements.** Downing, R.G. (California Inst. of Tech., Pasadena, CA); Curtis, H. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Since the inception of the terrestrial solar array standards program experiments have been conducted jointly between JPL and LeRC. The objectives of these experiments are to establish and maintain correlation of measurements performed at both laboratories and to demonstrate the existence of spectral matching of standard cells to solar modules under test. In the first series of experiments two standard cells were selected from each of two manufacturers having the most dissimilar spectral responses. Each manufacturer's standard cell was measured using the other manufacturer's standard cell as a reference forming a matrix of eight independent measurements. The ratios of measurements of like combinations of cells were formed for the six different possible combinations of simulators. The ratios show good agreement between the various simulators. Subsequent round-robin measurements have been performed on modules wherein specific modules and standard reference cells have been selected and measured in sunlight and in both the JPL and LeRC pulsed simulators. Results show excellent correlation when the reference cells are spectrally matched to the test module.

8166 (CONF-770112—, pp 269-276) **Problems in measurement of modules and arrays.** Curtis, H.B. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Performance measurement of solar cells, modules and arrays is a necessary adjunct to low-cost solar cell array development. Generally, modules and arrays are too large to test using conventional steady-state solar simulators, hence other methods for obtaining performance (I-V) measurements must be used. The approach used by NASA-Lewis is to measure modules indoors using a long arc xenon lamp pulsed solar simulator, and outdoors using natural sunlight. However, to fully characterize module or array performance, data should also be obtained at actual operating conditions. These data are needed to assess the effects of temperature on the array performance. These effects would most probably appear only under steady-state illumination. To determine these effects, data need to be taken at a variety of irradiance and temperature levels. The calibration number (current output/irradiance input) of a solar cell or module can vary significantly with changing atmospheric parameters. Variations of 5% or more are possible with reasonable changes in atmospheric variables.

8167 (CONF-770112—, pp 277-286) **Meaning and significance of the ERDA/LeRC Systems Test Facility.** Forestieri, A.F. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The ERDA/LeRC System Test Facility (STF) was designed and built and is being operated as a national facility to serve the needs of the entire ERDA National Solar Photovoltaic Program. The objective of the STF is to provide a place where photovoltaic systems may be assembled and electrically configured, without specific physical configuration, for operation and testing to evaluate their performance and characteristics. The STF provides a vital support function to the overall ERDA program. As a "breadboard" system it allows prompt preliminary in-house investigation and checkout of components, subsystems and systems before they are mounted in more elaborate and visible applications. Meetings are being held with other participants in the ERDA program to acquaint each organization with the capabilities of the facility, results of testing to date, and plans for future testing. In addition, each organization is solicited for testing needs that can be fulfilled by the facility so that maximum benefit to the national program is derived from the facility. The purpose, capabilities and a brief description of the STF are presented. Tests planned and the present status are discussed.

8168 (CONF-770112—, pp 287-295) **Effect of environmental factors on performance of the ERDA/LeRC Systems Test Facility.** Forestieri, A.F. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Some of the environmental factors which may affect the ERDA/LeRC System Test Facility (STF) solar cell array are wind, ambient temperature, snow, and partial shadowing of the array. These factors and others are being investigated and preliminary results are presented. Dirt, a factor which is dependent on the location of the array, has also been studied and typical effects are shown. Although the effect of environmental factors on STF are of primary interest it is also necessary to investigate the effect of the STF on the environment. For example, radiated electromagnetic interference, which could affect communication, is being investigated as a function of array size and system components operating. Some preliminary results are presented.

8169 (CONF-770112—, pp 296-303) **Power losses in the ERDA/LeRC Systems Test Facility.** Forestieri, A.F. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Power losses which may be found in photovoltaic systems such as the ERDA/LeRC System Test Facility can be attributed to many causes. Some losses can be limited by the design of the system. Others may not be limited or controlled but can be calculated and the system can be operated to minimize them. The array losses may be due to electrical line losses, solar cell module mismatches, dirt on the arrays, degradation of the arrays, temperature differences and others such as point failures or temporary losses due to clouds or shadow. Systems losses may be due to component inefficiencies, or operation at other than the optimum operating point. In the case of system controllers significant gains may be had if an array maximum power tracker is employed.

8170 (CONF-770112—, pp 304-311) **Module performance deterioration in the ERDA/LeRC Systems Test Facility.** Weinberg, I. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Several solar cell modules were removed from service and outdoor exposure in the ERDA/LeRC System Test Facility, cleaned with a detergent solution and I-V curves obtained in the Lewis Pulsed Xenon Simulator at air mass one and 28°C. These data were then compared to similarly obtained I-V data taken on receipt of the same modules from the vendor. The modules had been used in the System Test Facility for varying lengths of time. Brand X experienced 41 days of outdoor exposure, Brand Y 153 days and Brand Z 41 days. Comparing the exposed and cleaned module data to the as-received data, the changes in open circuit voltage and fill factor observed are small enough to be considered negligible within the accuracy of the measurements. In addition to these measurements decreases were observed in maximum power output and short circuit current. The decrease in maximum power after outdoor exposure ranged from -3.7% to -6.8% with short circuit current varying from -2.8% to -5.5%. These latter changes are evidence of performance deterioration, for the limited number of modules measured, as a result of outdoor exposure and use in the System Test Facility.

8171 (CONF-770922—2) **Laser annealed boron implanted silicon solar cells.** Young, R.T.; White, C.W.; Clark, G.J.; Narayan, J.; Westbrook, R.D. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From Photovoltaics solar energy conference; Luxembourg, Luxembourg (27 Sep 1977).

The use of high power laser pulses is being explored as a technique for annealing radiation damage in ion implanted silicon prior to the fabrication of solar cells. Extensive studies have been carried out to compare laser and conventional thermal annealing characteristics using $^{11}B^+$ (35 keV) implanted silicon (100) crystals. Our results show that laser annealing can completely restore electrical activity in the implanted layer with little or no degradation of the minority carrier lifetime in the substrate. Moreover, the residual disorder in the implanted layer is drastically reduced in comparison to that observed after conventional thermal annealing. Solar cells have been fabricated using $^{11}B^+$ (35 keV) implanted, laser annealed, 80 Ω-cm (100) Si. A substantial improvement in cell parameters is observed in laser annealed cells compared to similar cells fabricated using conventional thermal annealing. Results are presented to compare laser and thermally annealed ion implanted cells, and to compare these to cells fabricated using standard diffusion techniques. Possible reasons for the improvement in the laser annealed cells compared to the thermally annealed ion implanted cells are discussed.

8172 (CONF-771051—1) **Solar cells from ion-implanted, laser-annealed silicon.** Cleland, J.W.; Narayan, J.; Westbrook, R.D.; White, C.W.; Young, R.T. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 9p. Dep. NTIS, PC A02/MF A01.

From ERDA photovoltaics advance materials review meeting; Denver, Colorado, USA (4 Oct 1977).

As a part of the research program on solar energy conversion in the Solid State Division at the Oak Ridge National Laboratory, laser annealing of the lattice damage introduced by ion implantation of boron into silicon is being explored. The electrical properties of boron implanted silicon annealed by high power Q-switched ruby laser radiation have been compared with similar properties obtained on ion implanted thermally annealed samples. The defect structure of the implanted layer before and after both laser and thermal annealing has been studied by x ray, microscopy, transmission electron microscopy (TEM), ion channeling and secondary ion mass spectroscopy (SIMS). Solar cells have been fabricated using ion implantation-laser annealing, ion implantation-thermal annealing, and conventional thermal diffusion techniques for p-n junction formation. Results are presented and discussed.

8173 (ERDA/JPL/954405—77/6) **Automated array assembly task, Phase I. Quarterly report.** Carbajal, B.G. (Texas Instruments, Inc., Dallas (USA)). Jul 1977. Contract NAS-7-100-954405. 36p. Dep. NTIS, PC A03/MF A01.

Effort was concentrated on various aspects of a sensitivity analysis, in particular, on the impact of variations in metal sheet resistivity, metal line width, diffused layer sheet resistance, junction depth, base layer lifetime, optical coating thickness and optical coating refractive index and on process reproducibility for As diffusion from a polymer dopant source and on module fabrication. Model calculations show that acceptable process windows exist for each of these parameters. A follow-on program to define a 1982 factory will be initiated in the next quarter.

8174 (ERDA/JPL/954442—77/3) **Semiconductor grade, solar silicon purification project. Technical quarterly report No. 6, April 1, 1977—June 30, 1977.** Ingle, W.M.; Chaney, R.; Thompson, S. (Motorola, Inc., Phoenix, Ariz. (USA). Semiconductor Group). Sep 1977. Contract NAS-7-100-954442. 30p. Dep. NTIS, PC A03/MF A01.

An investigation has been undertaken to examine the potential for a three step SiF_2 polymer transport purification process. The process involves reacting low cost mg silicon with SiF_4 to yield SiF_2 gas which is condensed to form polymeric (SiF_2)/sub x/. The polymer is then heated above 400°C to yield Si, SiF_4 and higher Si/sub n/F/sub 2n+2/ homologues. Progress is discussed on (i) observations on (SiF_2)/sub x/ polymer formation and depolymerization on the small coil, (ii) mass balance studies, (iii) partial pressures of SiF_2 and SiF_4, (iv) AlF_3 mass spectral studies, and (v) material analysis studies.

8175 (ERDA/JPL/954471—77/2) **Novel duplex vapor-electrochemical method for silicon solar cells. Quarterly progress report No. 5, February 1, 1977—April 30, 1977.** Kapur, V.K.; Nanis, L.; Sanjurjo, A. (Stanford Research Inst., Menlo Park, Calif. (USA)). Jul 1977. Contract NAS-7-100-954471. 34p. Dep. NTIS, PC A03/MF A01.

Silicon was produced by alternate pulse feeding of the reactants SiF_4 gas and liquid sodium. The average temperature in the reactor could be controlled to within +-20°C in the temperature range 400-600°C, by regulating the amount of reactant in each pulse. Batches of reaction product (NaF, Na_2SiF_6, Si) as large as 250 g, containing 25 to 30 g of silicon, were prepared by the alternate pulse feeding technique. Silicon tetrafluoride gas was analyzed by mass spectrometry to determine the nature and amount of contained volatile impurities. The major impurities were found to be silicon oxyfluorides (approximately equal to 4.0%), sulfur oxyfluorides (approximately equal to 0.1%), and sulfur dioxide (0.05%). Sodium metal was analyzed by emission spectrography, and it was found to contain only calcium (100 ppM wt) and copper (8 ppM wt) as impurities. The decomposition of Na_2SiF_6 to NaF and SiF_4 was studies by an effusion method to determine the equilibrium pressure of SiF_4 at temperatures ranging from 585 to 650 K (312 to 377°C).

8176 (ERDA/JPL/954559—77/2) **Solar silicon via improved and expanded metallurgical silicon technology. Quarterly report No. 4.** Hunt, L.P.; Dosaj, V.D.; McCormick, J.R. (Dow Corning Corp., Hemlock, Mich. (USA). Solid-State Research and Development Lab.). Jul 1977. Contract NAS-7-100-954559. 87p. Dep. NTIS, PC A05/MF A01.

The goal of this program is to produce solar-cell-grade silicon at 3000 Mt/y for less than $10/kg by 1986. The approach is to

improve the quality of the 200,000-Mt/y process for producing $1/kg, 98-percent pure metallurgical silicon. A completed preliminary survey of silica sources indicates that sufficient quantities of high-purity quartz are available in the U.S. and Canada to meet LSSA goals. Supply can easily meet demand for this little-sought commodity. Charcoal, as a reductant for silica, can be purified to a sufficient level by high-temperature fluorocarbon treatment and vacuum processing. High-temperature treatment causes partial graphitization which can lead to difficulty in smelting. Smelting of Arkansas quartz and purified charcoal produced kilogram quantities of silicon having impurity levels generally much lower than in MG-Si. Half of the goal was met of increasing the boron resistivity from 0.03 ohm-cm in metallurgical silicon to 0.3 ohm-cm in solar silicon. A cost analysis of the solidification process indicates $3.50-7.25/kg Si for the Czochralski-type process and $1.50 to 4.25/kg Si for the Bridgman-type technique.

8177 (ERDA/JPL/954694—77/2) **Analysis of effects of impurities intentionally incorporated into silicon. Second quarterly report, May 2, 1977—July 29, 1977.** Uno, F.M. (Spectrolab, Inc., Sylmar, Calif. (USA)). 15 Aug 1977. Contract NAS-7-100-954694. 12p. Dep. NTIS, PC A03/MF A01.

A methodology has been developed and implemented to allow silicon samples containing intentionally incorporated impurities to be fabricated into finished solar cells under carefully controlled conditions. The electrical and spectral properties are then measured for each group processed, and these data, along with the material (cells and scrap), are delivered to JPL for further analysis. All 33 lots of Group "C" plus 3 lots each from the "CM" and "F" groups have been fabricated into cells, tested, and delivered to JPL.

8178 (N—77-21548) **Application of the SEM to the measurement of solar cell parameters.** Weizer, V.G.; Andrews, C.W. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. 8p. (NASA-TM-X—73637; E—9138). NTIS PC A02/MF A01.

From 10. annual scanning electron microscopy symposium; Chicago, IL, USA (28 Mar 1977).

Techniques are described which make use of the SEM to measure the minority carrier diffusion length and the metallurgical junction depth in silicon solar cells. The former technique permits the measurement of the true bulk diffusion length through the application of highly doped field layers to the back surfaces of the cells being investigated. It is shown that the secondary emission contrast observed in the SEM on a reverse-biased diode can depict the location of the metallurgical junction if the diode has been prepared with the proper beveled geometry. The SEM provides the required contrast and the option of high magnification, permitting the measurement of extremely shallow junction depths.

8179 (N—77-22609) **ERDA/Lewis Research Center photovoltaic systems test facility.** Forestieri, A.E.; Johnson, J.A.; Knapp, W.D.; Rigo, H.; Stover, J. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Apr 1977. Contract E(49-26)-1022. 34p. (NASA-TM-X—73641; E—9147). NTIS PC A03/MF A01.

A national photovoltaic power systems test facility (of initial 10-kW peak power rating) is described. It consists of a solar array to generate electrical power, test-hardware for several alternate methods of power conversion, electrical energy storage systems, and an instrumentation and data acquisition system.

8180 (N—77-22611) **A lightweight solar array study.** Josephs, R.H. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 15 Feb 1977. Contract NAS7-100. 39p. (NASA-CR—152676). NTIS PC A03/MF A01.

A sample module was assembled to model a portion of a flexible extendable solar array, a type that promises to become the next generation of solar array design. The resulting study of this module is intended to provide technical support to the array designer for lightweight component selection, specifications, and tests. Selected from available lightweight components were 127-micron-thick wrap-around contacted solar cells, 34- micron-thick sputtered glass covers, and as a substrate a 13-micron-thick polyimide film clad with a copper printed circuit. Each component displayed weaknesses. The thin solar cells had excessive breakage losses. Sputtered glass cover adhesion was poor, and the covered cell was weaker than the cell uncovered. Thermal stresses caused some cell delamination from the model solar array substrate.

8181 (N—77-22615) **Method for producing solar energy panels by automation.** Evans, J.C. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 25 Apr 1977. 24p. NTIS PC A02/MF A01.

The solar cell panel is fabricated by photoetching a pattern of collector grid systems with appropriate interconnection and bus bar tabs into a glass or plastic sheet and then filling these regions with a first, thin conductive metal film followed by a layer of a mixed metal oxide such as InAsO or InSnO. A multiplicity of solar cells are bonded between the protective sheet at the sites of the collector grid systems and a backelectrode substrate by conductive metal filled epoxy to complete the fabrication of an integrated solar panel.

8182 (N—77-24332) **Transmitter experiment package for the communications technology satellite.** Farber, B.; Goldin, D.S.; Marcus, B.; Mock, P. (TRW Defense and Space Systems Group, Redondo Beach, Calif. (USA)). 1977. Contract NAS3-15839. 200p. (NASA-CR—135035). NTIS PC A09/MF A01.

The operating requirements, system design characteristics, high voltage packaging considerations, nonstandard components development, and test results for the transmitter experiment package (TEP) are described. The TEP is used for broadcasting power transmission from the Communications Technology Satellite. The TEP consists of a 12 GHz, 200-watt output stage tube (OST), a high voltage processing system that converts the unregulated spacecraft solar array power to the regulated voltages required for OST operation, and a variable conductance heat pipe system that is used to cool the OST body.

8183 (N—77-24385) **A regulated high efficiency, lightweight capacitor-diode multiplier dc to dc converter.** Harrigill, W.T.; Myers, I.T. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 27 May 1977. 12p. NTIS PC A02/MF A01.

A voltage multiplier is described which has a capacitor-diode voltage multiplying network which is fed with voltage pulses from a dc source through a first switching means. Pulses of a second polarity are also supplied through a second switching means to the input of the capacitor-diode voltage multiplier from a second dc source whose voltage is adjustable to change the voltage of the pulses of second polarity. The switching means are alternately rendered conducting by signals from a control circuit. The second dc source may be controlled by a voltage comparator which compares the output voltage of the capacitor-diode voltage multiplier to the reference source.

8184 (N—77-24581) **Solar breeder: energy payback time for silicon photovoltaic systems.** Lindmayer, J. (Solarex Corp., Rockville, Md. (USA)). Apr 1977. Contracts NAS7-100;JPL-954606. 57p. (NASA-CR—153060). NTIS PC A04/MF A01.

The energy expenditures of the prevailing manufacturing technology of terrestrial photovoltaic cells and panels were evaluated, including silicon reduction, silicon refinement, crystal growth, cell processing and panel building. Energy expenditures include direct energy, indirect energy, and energy in the form of equipment and overhead expenses. Payback times were development using a conventional solar cell as a test vehicle which allows for the comparison of its energy generating capability with the energies expended during the production process. It was found that the energy payback time for a typical solar panel produced by the prevailing technology is 6.4 years. Furthermore, this value drops to 3.8 years under more favorable conditions. Moreover, since the major energy use reductions in terrestrial manufacturing have occurred in cell processing, this payback time directly illustrates the areas where major future energy reductions can be made -- silicon refinement, crystal growth, and panel building.

8185 (N—77-24584) **Silicon material task. part 3: low-cost silicon solar array project. Final report.** Roques, R.A.; Coldwell, D.M. (Texas Instruments, Inc., Dallas (USA)). Jan 1977. Contracts NAS7-100;JPL-954412. 74p. (NASA-CR—153064; ERDA/JPL—954412-77-PT-3). NTIS PC A03/MF A01.

The feasibility of a process for carbon reduction of low impurity silica in a plasma heat source was investigated to produce low-cost solar-grade silicon. Theoretical aspects of the reaction chemistry were studied with the aid of a computer program using iterative free energy minimization. These calculations indicate a threshold temperature exists at 2400 K below which no silicon is formed. The computer simulation technique of molecular dynamics was used to study the quenching of product species.

8186 (N—77-24585) **Critical areas: satellite power systems concepts.** (National Aeronautics and Space Administration, Houston, Tex. (USA). Lyndon B. Johnson Space Center). Jul 1975. 168p. (NASA-TM-X—74694; JSC—10873). NTIS PC A08/MF A01.

Critical Areas are defined and discussed in the various areas pertinent to satellite power systems. The presentation is grouped into five areas (General, Space Systems, Solar Energy Conversion, Microwave Systems, and Environment/Ecology) with a sixth area (Power Relay) considered separately in an appendix. Areas for Future Consideration as critical areas are discussed in a second appendix.

8187 (NP—22423) **Some public policy aspects of photovoltaic development.** Lindmayer, J.; Clifford, A. (Solarex Corp., Rockville, Md. (USA)). 14 Aug 1976. 17p. Corp., Rockville, MD.

The material presented attempts to outline the general conditions that could affect the development of photovoltaics. The view-

points expressed represent a learning experience gained in trying to establish the terrestrial solar cell industry. The government role is emphasized if solar cells are to become cost-competitive within a reasonable amount of time. However, an aggressive development program should not require excessive government expenditures. There have been many cost estimates made before for an aggressive approach in the photovoltaic area. Nevertheless, time is the challenge and an evolutionary approach is the method by which photovoltaics should be developed.

8188 Gallium arsenide films on recrystallized germanium films. Chu, S.S.; Chu, T.L.; Monroe, S.; Wang, C.P.; Yang, H.T. (Southern Methodist University, Dallas, Texas 75275). *J. Appl. Phys.;* **48**: No. 11, 4848-4849(Nov 1977).

Germanium films deposited on tungsten/graphite substrates have been recrystallized by a unidirectional solidification technique. Gallium arsenide films deposited on recrystallized germanium have elogated grains with a strong {111} preferred orientation and are epitaxial with respect to the substrate. The deposited films have a room-temperature Hall mobility of 600—700 cm^2/V sec and electron concentration of (1—3) x 10^{17} cm^{-3}.

8189 From light make current. The way in which sunlight is converted into utilizable energy in US laboratories. Haaf, G. *Zeit.;* No. 37, 3(Sep 1976). (In German).

1 fig.

Activities in the US concerning the economical utilization of solar energy by means of solar cells are reported on. Special reference is made to a system developed by MIT which reflects the sunlight via concave mirrors of a size of 1 qm on to a small mirror in the center, from whence the sunlight is thrown through a hole on to a solar cell plate of the size of a hand. By means of a simple feedback system the solar reflectors are centered optimally with small electromotors. It is intended to draw off the heat via a cooling system, the thermal energy of which can be used for making hot water. Other systems work with stationary Fresnel lenses and solar cells made of different semiconductor materials.

8190 Semiconductors and semimetals. Volume 11. Solar cells. Hovel, H.J. New York; Academic Press, Inc. (1975). 254p.

An introduction to solar cells and to the material and device parameters most important to these devices is presented. The process of photocurrent generation and the spectral response and the electrical behavior in the dark are described. The efficiencies of Si, GaAs, and CdS solar cells under various conditions are discussed. The trends in behavior caused by changes in junction depth, doping levels, base and top region lifetimes, surface recombination velocities, presence or absence of aiding electric fields are shown. The effects of thickness on solar cells behavior are discussed, together with the effects of grain boundaries in polycrystalline films. An introduction is given to Schottky barrier, heterojunction, vertical multijunction, and grating solar cells. Radiation effects on cells exposed to the space environment are discussed and device behavior under various temperature and intensity environments is described. Solar cell technology is introduced, including crystal growth, diffusion, ion implantation, antireflective coatings, and Ohmic contacts. (MHR)

BIOMASS PRODUCTION AND CONVERSION

8191 (COO/2991—76/4) **Fuel gas production from animal waste. Phase I. Quarterly progress report (1st), May 17, 1976—September 1, 1976. Dynatech report No. 1519.** Ashare, E.; Wentworth, R.L.; Wise, D.L.; Augenstein, D.C.; Anderson, L.C. (Dynatech R/D Co., Cambridge, Mass. (USA)). 17 Sep 1976. Contract EY-76-C-02-2991. 13p. Dep. NTIS, PC A02/MF A01.

Meetings held with all contractors on the ERDA fuel gas from animal waste program are listed. These meetings were held for project planning, project review, and contractor site visits. Engineering analysis of the anaerobic digestion process for the demonstration plant is being carried out. Expressions for material balances have been developed. Several proposals were received from ERDA and reviewed.

8192 (LBL—5960) **Decomposition of lignin and cellobiose in relation to the enzymatic hydrolysis of cellulose.** Yamanaka, Y.; Carroad, P.A.; Riaz, M.; Wilke, C.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1977. Contract W-7405-ENG-48. 29p. (CONF-761166—1). Dep. NTIS, PC A03/MF A01.

From 2. symposium on research applied to national needs; Washington, District of Columbia, United States of America (USA) (7 Nov 1976).

Studies are reported on the use of fungal β-glucosidase in conjunction with Trichoderma viride cellulase and the search for an effective enzyme system for lignin degradation. β-glucosidase is of potential benefit in cellulose hydrolysis by catalyzing the hydrolysis of cellobiose to glucose thereby reducing product inhibition and producing a higher glucose yield. Removal of lignin from cellulosic material makes the cellulose more accessible to hydrolyzing enzymes. Hydrolysis studies on Solka Floc and newsprint were conducted with T. viride filtrates containing various proportions of B. theobromae filtrates. Significant improvement in hydrolysis rate particularly in glucose content was obtained by thus enriching the β-glucosidase content of the cellulase. In the search for a lignin degrading enzyme, major emphasis was given to the fungus Polyporous versicolor. Significant o-diphenol oxidoreductase (catecholase) activity was found in the culture filtrates. Preliminary observations of a surface culture of the fungus in a composting mode suggest that delignification may be obtained in this manner. Work is continuing on this.

PHOTOCHEMICAL CONVERSION

8193 Solar hydrogen generator. Sebacher, D.I.; Sabol, A.P. US Patent 4,019,868. 26 Apr 1977. 5p.

An apparatus, using solar energy to manufacture hydrogen by dissociating water molecules into hydrogen and oxygen molecules is described. Solar energy is concentrated on a globe containing water thereby heating the water to its dissociation temperature. The globe is permeable to hydrogen molecules permitting them to pass through the globe while being essentially impervious to oxygen molecules. The hydrogen molecules are collected after passing through the globe and the oxygen molecules are removed from the globe.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 8143, 8144, 8204

8194 (CONF-770112—, pp 336-377) **Comparison of photovoltaic conceptual design studies.** Marshall, B.W. (Sandia Labs., Albuquerque, NM). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

In June 1975, the Photovoltaics Branch of the Division of Solar Energy, ERDA, initiated contracts with General Electric, Spectrolab, and Westinghouse for 1-year conceptual design studies of photovoltaic systems. The contracts required studies for three concepts; an on-site residential system (RPS), a central power station (CPS), and an intermediate power system (IPS). Results of the studies were not interchanged between contractors during the contract period as encouragement for each to develop independent concepts. These studies, including 3-month extensions, have been completed and the final reports are in preparation. Sandia Laboratories, as a part of their Photovoltaic System Analysis Project, undertook the technical direction for these studies in November 1975, and is presently preparing an evaluation and comparison of these studies. Although this effort is not totally complete, much of the information has been accumulated and is presented.

8195 (CONF-770112—, pp 408-420) **Status of power conditioning technology.** Kroeger, F.R. (Sandia Labs., Albuquerque, NM). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The evaluation of power conditioning technology is in support of the ERDA/Sandia Laboratories Solar Photovoltaic Systems Definition Project. The primary objectives of this support effort, which began mid-FY76, are (1) evaluate power conditioning industry; (2) formulate design specifications for power conditioning hardware in photovoltaic system applications, including utility interfacing for the last three; (3) make recommendations for ERDA power conditioning hardware development program; and (4) contract for innovative hardware development. The first objective has received the most emphasis to date. Design specifications will be formulated in the near future. Hardware development recommendations and contracts (where appropriate) will follow.

8196 (CONF-770112—, pp 421-436) **System test facility power conditioning hardware testing.** Pickrell, R.L. (Lewis Research Center, Cleveland). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

Inverters are required to convert the dc power available at the solar array output terminals to the ac power form required to drive most electric devices in this country. Tests on three type designs for single phase line voltages are planned for the STF. The first two are off-the-shelf designs and are already installed in the STF. The third is in the procurement process and will be custom tailored to better match the PV application requirements. Perfor-

mance data from the first unit under test, a line commutated 8 kw inverter, are presented together with a discussion of its operating characteristics. The second unit, a 5 kva unit for stand-alone system operations, has just been installed and data is not available yet, except for manufacturers specifications. The 10 kva new design unit performance goals and a discussion of the special requirements for photovoltaic applications are presented. In addition, block diagrams showing parameter measurements and specialized measurement equipment are presented. Tests conducted to date, have demonstrated that inverters can be operated to extract energy from a solar array and transfer that energy to a commercial power system in a controlled manner to optimize the amount of energy output from the solar array. Plans are underway to design, build and deliver a custom designed self-commutated 10 kva inverter by September 1977 for photovoltaic applications.

8197 (CONF-770112—, pp 437-446) **Applied research on energy storage and conversion for photovoltaic and wind energy systems.** Johnson, A.W. (General Electric Co., Philadelphia). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The overall purpose of the program, as originally conceived. was to obtain system-oriented evaluations of selected candidate energy storage concepts for use in conjunction with photovoltaic and wind energy conversion systems. Included are: (1) review of additional candidate energy storage concepts (11 total); (2) evaluation of the influence of selected parameters such as generating system output, storage capacity, location and efficiency on energy storage cost goals; (3) evaluation of the effect of multiple-source storage system charging on the worth of photovoltaic and wind energy systems; and (4) determination of the value of transient photovoltaic and wind energy system output smoothing using energy storage techniques.

8198 (CONF-770112—, pp 447-481) **Research on energy storage for photovoltaic conversion.** Kirschbaum, H.S.; Federmann, E.F. (Westinghouse Electric Corp., Pittsburgh). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The overall objective of the one-year program is to determine and define the nature, mode of operation and usefulness and define actions, regarding any technical and/or implementation problems, regarding battery-stored energy, when applied to both single family residences and utility central station systems that would use photovoltaic-derived electricity, circa 1985-1995.

8199 (CONF-770112—, pp 482-484) **Battery storage performance requirements for terrestrial solar photovoltaic power systems.** Stolte, W.J. (Bechtel Corp., San Francisco). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The Engineering and Research Operation of Bechtel Corporation has conducted a 4 month study to determine the characteristics required by batteries used for energy storage in photovoltaic power systems. A broad spectrum of terrestrial photovoltaic applications was evaluated in general by considering the types of loads served and the characteristics of system components. Four applications, representative of low, intermediate, and high power systems, were then considered in detail. These systems include a single residence, a multiple residence, a shopping center, and a central station power plant.

8200 (CONF-770112—, pp 502-557) **Definition study for photovoltaic residential prototype system.** Imamura, M.S. (Martin Marietta Corp., Denver). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The objectives of the Residential Photovoltaic Prototype System Test (PST) are: (1) determine information needed to implement PST; (2) define PST configuration, including test plan, test procedure, and test equipment. Secondary objectives are: (1) select eight regions in continental U.S., rate these regions, and identify three potential PST sites per region; (2) identify institutional problems.

SOLAR THERMAL POWER PLANTS

8201 **JPL develops a microwave power transmission system.** *MBB Inf.-Raumfahrttech.;* No. 3/4, 47-51(1976). (In German).

4 figs.; 1 ref.

The report is on tests which were undertaken by the firm JPL. These pricipal undertakings had the aim to test the feasibility of an earth-linked energy satellite in orbit collect and transforming solar energy and transmitting it through a microwave plant to the earth, proposed in 1968 by the firm Arthur D. Little. In its first phase, the 5 years' programme is to do with reception and directioning of microwaves. A 26 m antenna was set up as relay antenna. By means of a 450 kW-dystron amplifier, the reflected energy conducted 323 kW. The received microwave energy from the 1,6 km distant relay antenna conducted 36,8 kW, corresponding 11.4% to the reflected energy. The level of energy transformed conducted 80 to 85% to the receivers.

8202 (N—77-21136) **Solar power satellite: analysis of alternatives for transporting material to geosynchronous orbit.** Graff, W.J.; Huang, C.J. (National Aeronautics and Space Administration, Houston, Tex. (USA). Lyndon B. Johnson Space Center). 1976. Contract NGT-44-005-114. 265p. (NASA-TM-X—74680). NTIS PC A12/MF A01.

A systems design study of the alternative methods and relative merits of various approaches to transporting and assembling a solar power satellite in geosynchronous orbit was conducted. State of the art alternatives for chemical and electrical interorbital propulsion were studied, and several possible scenarios for construction were proposed.

8203 (N—77-21547) **Operations research investigations of satellite power stations.** Cole, J.W.; Ballard, J.L. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Dec 1976. 41p. (NASA-TM-X—73372). NTIS PC A03/MF A01.

A systems model reflecting the design concepts of Satellite Power Stations (SPS) was developed. The model is of sufficient scope to include the interrelationships of the following major design parameters: the transportation to and between orbits; assembly of the SPS; and maintenance of the SPS. The systems model is composed of a set of equations that are nonlinear with respect to the system parameters and decision variables. The model determines a figure of merit from which alternative concepts concerning transportation, assembly, and maintenance of satellite power stations are studied. A hybrid optimization model was developed to optimize the system's decision variables. The optimization model consists of a random search procedure and the optimal-steepest descent method. A FORTRAN computer program was developed to enable the user to optimize nonlinear functions using the model. Specifically, the computer program was used to optimize Satellite Power Station system components.

8204 (N—77-22612) **An initial comparative assessment of orbital and terrestrial central power systems. Final report.** Caputo, R. (Jet Propulsion Lab., Pasadena, Calif. (USA)). Mar 1977. Contract NAS7-100. 160p. (NASA-CR—152688). NTIS PC A08/MF A01.

Orbital solar power plants, which beam power to earth by microwave, are compared with ground-based solar and conventional baseload power plants. Candidate systems were identified for three types of plants and the selected plant designs were then compared on the basis of economic and social costs. The representative types of plant selected for the comparison are: light water nuclear reactor; turbines using low BTU gas from coal; central receiver with steam turbo-electric conversion and thermal storage; silicon photovoltaic power plant without tracking and including solar concentration and redox battery storage; and silicon photovoltaics.

8205 **Use of solar energy in large solar power plants.** Meinhardt, H. *Elektr. Energie-Tech.;* **21**: No. 18, 375-380(Sep 1976). (In German).

11 figs.

The article first gives a survey of the energy sources on the earth: fossil fuels, nuclear energy, and non-conventional energy sources. Solar energy has a special position among the energy sources. Characteristic values for solar radiation are given. Finally, large solar power plants, air heat power plants and sea heat power plants are discussed with regard to their profitability and applicability.

8206 **Solar—thermal power system.** Denton, J.C. (American Technological Univ., Killeen, TX). pp 219-243 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

Solar-power-systems that have been investigated extensively are presented. The variation of solar flux or insolation is presented. Focusing and nonfocusing collectors of the thermal variety are discussed including central receivers, tower focus and linear parabolic collectors. Energy storage and electric power utility considerations are covered. (MHR)

OCEAN THERMAL GRADIENT POWER PLANTS

8207 (N—77-21666) **Ocean thermal plant.** Owens, L.J. (National Aeronautics and Space Administration, Cocoa Beach, Fla. (USA). John F. Kennedy Space Center). 29 Mar 1977. 18p. NTIS PC A02/MF A01.

An ocean thermal plant consisting of a floating energy converter utilizing large volumes of sea water to produce electrical power is described. In this plant, a fluid working medium is pumped to an evaporator where it is heated by a flow of warm surface sea water. The fluid in liquid form boils to a pressurized gas vapor which is routed to drive a turbine that, in turn, drives a generator for producing electricity. The gas vapor then enters a condenser immersed in cold sea water pumped from lower depths. The gas vapor condenses to its original liquid form and is then pumped to the evaporator to repeat the cycle. Modular components can be readily interchanged on the ocean thermal unit, and inlet pipes for the sea water are provided with means for maintaining the pipes in alignment with the oncoming current. The modular construction allows for the testing of various components to provide a more rapid optimization of a standardized plant.

8208 (PB—268096) **Incentives for the commercialization of ocean thermal energy conversion technology (OTEC). Executive summary.** Washom, B.J.; Nilles, J.M.; Lutz, R.E.; Nachtigal, D.; Schmidhauser, J.R. (University of Southern California, Los Angeles (USA). Office of Interdisciplinary Program Development). Jan 1977. 57p. NTIS PC A04/MF A01.

This research program is concerned with the identification of legal, jurisdictional, environmental, institutional, and other nontechnological barriers to the development of solar energy technologies in general, and OTEC in particular. The report concentrates on assessing the economic competitiveness with time of OTEC relative to conventional energy plants, both under existing institutional and regulatory conditions, and as they might appear if the institutional and regulatory conditions and constraints were altered in various ways.

8209 (PB—268097) **Incentives for the commercialization of ocean thermal energy conversion technology (OTEC).** Washom, B.J.; Nilles, J.M.; Lutz, R.E.; Nachtigal, D.; Schmidhauser, J.R. (University of Southern California, Los Angeles (USA). Office of Interdisciplinary Program Development). Jan 1977. 354p. NTIS PC A16/MF A01.

This research program is concerned with the identification of legal, jurisdictional, environmental, institutional, and other nontechnological barriers to the development of solar energy technologies in general, and OTEC in particular, and with the formulation of recommendations for strategies designed to diminish these barriers. The report concentrates on assessing the economic competitiveness with the time of OTEC relative to conventional energy plants, both under existing institutional and regulatory conditions, and as they might appear if the institutional and regulatory conditions and constraints were altered in various ways.

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 8131, 8137

8210 (COO/4229—1) **Model validation studies of solar systems, Phase III. Monthly report.** Winn, C.B.; Duong, N.; Hull, D.; Lantz, L. (Solar Environmental Engineering Co., Inc., Fort Collins, Colo. (USA)). Jul 1977. Contract EG-77-C-02-4229. 43p. Dep. NTIS, PC A03/MF A01.

A comparison between SOLCOST and FCHART solar system simulation models for solar space heating and service hot water systems, both using air as the collector fluid, is presented. Details of an algorithm for sizing cross-flow heat exchangers for a solar house are given. Also, a mathematical model of the CEM (Center for The Environment and Man) insolation prediction model is given, followed by a residual analysis of point comparisons for six locations. Two sensitivity studies were performed on the insolation models and the results are discussed. (WHK)

8211 (MP—898) **Economic feasibility of heating Maryland broiler houses with solar energy.** Cain, J.L.; Van Dyne, D.L. (Maryland Univ., College Park (USA). Agricultural Experiment Station). Feb 1977. 55p. of Maryland, College Park.

The economic feasibility of heating Maryland broiler houses with solar energy was examined utilizing simulation and present value cost effectiveness. Simulation was used to analyze (1) weather data; (2) building heat requirements; and (3) the portion of total heating needs to be supplied by each solar collection, storage, and distribution system. Present-value cost effectiveness was applied to the simulation results to determine when the optimum combination of solar collection, storage, and distribution units (solar system) would become less expensive than conventional fuels over a 20-year period. The simulation analysis, utilizing some 150 different combinations of size and quality of solar collection and storage systems, yielded the following results (on an annual basis): (1) the test solar systems provided from 24.31 to 85.85% of total building heat requirements; (2) solar system efficiency ranged from 15.32 to 4.52%; and (3) solar heat overflow was 0.17 to 27.49% of total heat available to the collection. Other results are presented and discussed.

8212 (N—77-21700) **Potential heat production of various types of collectors under the climatological circumstances of the Netherlands.** Denouden, C. (Nijverheidsorganisatie TNO, Delft (Netherlands). Centraal Lab. TNO). 1976. 28p. NTIS PC A03/MF A01.

The possibility of producing heat with solar energy collectors in the Netherlands is discussed. Efficiency formulas for flat plat collectors are given and efficiency in practice and possibilities of improving efficiency are discussed. The yearly solar energy production is compared with various collector types and the influence of the collector heat capacity on energy capture is discussed. The thermal behavior of a solar house is dealt with.

8213 (N—77-22613) **Solar energy in buildings: implications for California energy policy.** Hirshberg, A.S.; Davis, E.S. (Jet Propulsion Lab., Pasadena, Calif. (USA)). Mar 1977. Contract NAS7-100. 136p. (NASA-CR—152686). NTIS PC A07/MF A01.

An assessment of the potential of active solar energy systems for buildings in California is summarized. The technology used for solar heating, cooling, and water heating in buildings is discussed. The major California weather zones and the solar energy designs are described, as well as the sizing of solar energy systems and their performance. The cost of solar energy systems is given both at current prices and at prices consistent with optimistic estimates for the cost of collectors. The main institutional barriers to the wide spread use of solar energy are summarized.

8214 (NP—22219) **Federal procurement plan to accelerate use of solar energy. Federal Energy Administration solar energy government buildings program.** (Sowle (Don) Associates, Inc., Arlington, Va. (USA)). Dec 1976. 113p. Energy Administration, Washington, DC.

The Solar Energy Government Buildings Program (SEGBP) is a major commercialization project being developed by the Federal Energy Administration in conjunction with other agencies. This project will utilize a portion of the vast inventory of Federal buildings to provide an early and significant market for solar heating and hot water equipment and thus assist the early development of a solar heating and cooling industry infrastructure. The report analyzes several aspects of the Federal procurement process that can be used in pursuring the goals of the SEGBP to: (1) encourage use of solar energy systems in new and existing structures; (2) stimulate industry towards increasing investment in facilities designed to expand production and reduce costs; (3) stimulate marketing activities in the private sector; and (4) enhance equipment quality with improvement in performance-to-cost ratios. The procurement procedures, methods, and tools described for use in the report are designed to remove or minimize current major constraints in achieving rapid and widespread use of solar systems. These constraints include: (1) the high initial cost of solar systems; (2) present high costs of systems compared with lower costs which should result from volume production; and (3) potential inability of producers to obtain capital, or unwillingness to risk available capital for creation and expansion of production facilities. Key features of Government procurement as part of an overall implementation plan for the SEGBP are addressed. The report reviews trends and techniques in Government procurement, discusses alternative strategies, and sets forth a procurement plan to achieve SEGBP goals and objectives.

8215 **Solar energy on the road to practical use. 'Domestic use' may be possible in five years.** Matthoefer, H. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). *Beratende Ing.;* No. 1/2, 16-20(1976). (In German).

7 figs.

The state of development in the FRG is described in a general manner and explained by means of 3 complete test systems (experimental house Aachen, solar house Essen, open-air bath Wiehl).

8216 (ORO/4976—77/1) **Solar powered absorption air-conditioning system performance predictions using stochastic weather models.** Anand, D.K.; Allen, R.W.; Bazques, E.O. (Maryland Univ., College Park (USA). Dept. of Mechanical Engineering). Sep 1977. Contract EY-76-S-05-4976. 123p. Dep. NTIS, PC A06/MF A01.

The performance of a solar powered absorption air-conditioning system using real and synthetic weather data is obtained for the entire cooling season. Both air-cooled and water-cooled systems are considered. The synthetic data is derived using weather history and represented by a joint probability density matrix and at most six constants. Total insolation and the system coefficient of performance

using real data and synthetic data are compared. Long term monthly and cooling season predictions based on synthetic data for both air-cooled and water-cooled systems are quite good. It is concluded that the use of synthetic data allows very inexpensive simulation and yields satisfactory results for design purposes.

8217 (PB—267447) **North View Junior High School solar energy demonstration project. Quarterly progress report 1 Dec 1974—28 Feb 1975.** Merrill, G.L. (Honeywell, Inc., St. Paul, Minn. (USA). Systems and Research Center). 10 Apr 1975. Contract NSF-C870. 150p. NTIS PC A07/MF A01.

This report covers the operation of the solar energy demonstration project during the winter in Minneapolis. Snow accumulating on the collectors caused a marked drop in the efficiency of the collectors. In spite of some melting, new accumulations eventually covered about 30% of the collectors. This report shows the operation of the system through this period of snow, cold weather, and some other mechanical problems. Insolation, collected energy, efficiency, inlet temperature, outlet temperature, and ambient temperature plotted for each day of operation for the months of December, January, and February are tabulated.

8218 (PB—267832) **Early use of solar energy in buildings: a study of barriers and incentives to the widespread use of solar heating and cooling systems.** (AIA Research Corp., Washington, D.C. (USA)). Aug 1976. 195p. NTIS PC A09/MF A01.

Section I of this report presents the principal findings, outlines the methodology, and presents the results of a national survey of the early users of the technology. It also outlines the utilization processes of the first wave of building industry professionals who have used solar technology in satisfying their clients' demand for environmental conditioning in buildings. It describes the use of the technology and implementation of the knowledge in the building process. A summary structure of incentives is also presented. Section II presents the results of life cycle cost analyses of fifteen selected solar heating projects, as well as a general overview of the various economic factors relating to the commercialization of solar technology. Section III presents a regulatory analysis of sun rights and land use, building codes, warranties of performance, rights to energy, and the implications of these rights.

8219 (SAND—77-1204) **Passive solar buildings: a compilation of data and results.** Stromberg, R.P.; Woodall, S.O. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1977. Contract EY-76-C-04-0789. 74p. Dep. NTIS, PC A04/MF A01.

As a result of increasing interest in the application of passive solar techniques to the heating of buildings, the need has arisen for a document which will assist construction of additional passive experiments by presenting actual test data on several quite successful passive buildings. The buildings are situated in a variety of locales and demonstrate the use of direct gain, Trombe wall, solar greenhouse, and roof pond with movable insulation principles. The report also contains a discussion of the methods for determining the heating and cooling needs of a passive solar building and includes timely information from several recently published documents relating to passive solar design. References are included for additional information.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

8220 **French CNRS 1000 kW solar furnace: description, performance characteristics, present utilization, and perspectives.** Trombe, F.; Le Phat Vinh, A.; Royere, C. (CNRS Solar Energy Lab., Font Romeu, France). pp 183-217 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

The history, facility description, energetic performance characteristics, and methods for measuring heat flux density are discussed. The utilization of the solar furnace for thermal shock studies and processing refractory materials is described. Processing in a cavity centrifugal furnace, apparatus for processing piled materials, and processing a fixed-cavity furnace are discussed. (MHR)

WATER HEATING

REFER ALSO TO CITATION(S) 8210, 8214

8221 (PB—268514) **Further development of the compressed-film floating-deck solar water heater. Final report.** Davison, R.R.; Harris, W.B. (Texas A and M Univ., College Station (USA). Dept. of Chemical Engineering). Apr 1977. 84p. NTIS PC A04/MF A01.

This heater with integral storage and low heat capacity solves many of the problems typical of large horizontal pillow type solar heaters. In phase I of this research, two highly instrumented, small-scale models of the Compressed-Film Floating-Deck heater were built and tested. Operation was satisfactory and results typical of flat plate collectors. In phase II, design specifications for large-scale floating-deck collectors were developed, and a 500 sq ft unit was built and tested.

8222 **Heating of swimming pools with solar collectors.** Albrecht, H.; Hewig, G. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Physikalische Elektronik). *Schimmbad Sauna.;* No. 31, 28-37(1975). (In German).

With figs.

Experience with the simplest solar energy converter, the thermal flat plate collector, in connection with the heating of swimming pools is reported on. It is described in detail how a heating system of this kind has to be constructed for an open-air swimmung pool of 10 m x 4 m x 1.5 m with an average water temperature of 23 degrees C.

8223 **Solar collectors for swimming pools still going strong.** *Schwimmbad Sauna.;* No. 32, 54-55(1975). (In German).

With figs.

According to the opinion of the experts, solar energy heating may be technically 'mature' but the profitability is by no means that far. However, solar systems are a good alternative for heating the water in swimming pools. Four solar collector systems developed by different firms to heat swimming pools, including prices, are presented.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 8141, 8150, 8152, 8153, 8154, 8155, 8156, 8157, 8158, 8206

8224 (CONF-770112—, pp 1-19) **Automated Array Assembly Task, Phase I. Jet Propulsion Laboratory.** Carbajal, B.G. (Texas Instruments Inc., Dallas). 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The overall goal of the Automated Array Assembly Task, Phase I, of the Low-Cost Silicon Solar Array Project is a comprehensive assessment of the processes, conceptual designs, and new technologies required to achieve, by 1985, annual solar cell array production capability greater than 500 megawatts per year at a cost less than $500 per kilowatt. This goal is being approached from two directions. The first is to build a model or models of the costs involved in the various steps used to fabricate solar cell modules. These costs are being analyzed in terms of present-day capabilities and projected capabilities. Also, new technologies will be fitted to these models to determine the cost ranges for solar cell processing using new or emerging technologies. The second approach is to determine the cost goals for each of the processing steps. The program will then undertake a series of studies that are intended to point the way from existing and projected costs to the cost goals. This design-to-cost concept will establish allowable costs for each cell manufacture/array assembly step consistent with the 1985 cost goals.

8225 (COO—2929-6) **Low-cost solar air heater. Semi-annual progress report, June 29, 1976—December 22, 1976.** Rask, D.R.; Mueller, L.J. (Honeywell, Inc., Minneapolis, Minn. (USA). Energy Resources Center). 22 Dec 1977. Contract EY-76-C-02-2929. 89p. Dep. NTIS, PC A05/MF A01.

The results to date on the development of a low-cost solar air heater are described. A unique jet-impingement concept is used as the absorber plate-to-air stream heat-transfer mechanism. The program objective is to design, fabricate, test and evaluate the jet-impingement concept collector. For comparison purposes, a baseline parallel-plate collector was analyzed, fabricated and tested. Values for the average jet-heat transfer coefficient are predicted and presented. A computer simulation using a nodal network collector model is used to predict collector performance. The predicted efficiency improvement of the jet-plate collector over that of the parallel-plate collector, at a fixed-flow rate of 1.47 kg/min-m2(4SCFM/ft^2), is approximately 11 percent for a one-cover design and 9 percent for a two-cover design. If the existing selective absorber coating and etched cover glass technology of Honeywell is applied to the jet-plate collector, the resulting performance gain over the baseline parallel-plate collector is 21 percent at the intercept and 35 percent for a typical space heating application. The collector mechanical design effort involved a study of cost effective methods for assembly and material selection. A preliminary recommended design is presented. In summary, it has been recommended that aluminized steel sheet, pre-painted with an acrylic paint, be used for the box material. A semi-rigid fiber glass, 2.54-cm (1-inch) thick, with an aluminum facing is recommended for the insulation. A steel absorber plate and a pre-assembled nozzle plate or perforated plate is used for the jet plate. Two sheets of 0.318-cm (0.125 inch) tempered, low-iron glass are recommended for the glazings. The baseline parallel plate test results are presented. Since jet-plate collector testing had just commenced at the time of this writing, we have no test results.

8226 (N—77-24582) **An analytical and experimental investigation of a 1.8 by 3.7 meter Fresnel lens solar concentrator.** Hastings, L.J.; Allums, S.L.; Jensen, W.S. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Apr 1977. 75p. (NASA-TM-X—73392). NTIS PC A04/MF A01.

Line-focusing acrylic Fresnel lenses with application potential in the 200 to 370 C range are analytically and experimentally evaluated. Investigations previously conducted with a 56 cm wide lens were extended to experimentation/analyses with a 1.8 by 3.7 m lens. A measured peak concentration ratio of 64 with 90 percent of the transmitted energy focused into a 5.0 cm width was achieved. A peak concentration of 61 and a 90 percent target width of 4.5 cm were analytically computed. The experimental and analytical lens transmittance was 81 percent and 86 percent, respectively. Thus, the analytical/experimental lens performance correlation is considered good. The lens also was interfaced with a receiver assembly and operated in the collection mode. The collection efficiency ranged from 42 percent at 100 C to 26 percent at 300 C, whereas an efficiency of 40 percent at 300 C was anticipated. Apparently, the reflective cavity surrounding the absorber tube did not perform as expected.

8227 (N—77-24587) **Baseline performance of solar collectors for NASA Langley solar building test facility.** Knoll, R.H.; Johnson, S.M. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). May 1977. 25p. (NASA-TM-X—3505; E—9036). NTIS PC A02/MF A01.

The solar collector field contains seven collector designs. Before operation in the field, the experimental performances (thermal efficiencies) of the seven collector designs were measured in an indoor solar simulator. The resulting data provided a baseline for later comparison with actual field test data. The simulator test results are presented for the collectors as received, and after several weeks of outdoor exposure with no coolant (dry operation). Six of the seven collector designs tested showed substantial reductions in thermal efficiency after dry operation.

8228 (SAND—77-0492) **Tracking and shadowing models for solar collection systems.** Schimmel, W.P. Jr.; Hickox, C.E.; Lee, D.O. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 25p. (CONF-771120—7). Dep. NTIS, PC A02/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, Georgia, USA (27 Nov 1977).

A unified, systematic method, based on vector algebra, has been presented from which numerous geometric results, important to the effective collection of solar energy, can be deduced. Results were obtained in a straightforward manner from first principles. Since the results are general in nature, local weather bureau data can be used effectively when comparing various proposed systems. Furthermore, the generality of the results allows the influence of system parameters to be investigated with a minimum of difficulty. Specifically, the geometry of the sun-Earth system and the orientation of surfaces on the Earth relative to the sun have been specified in terms of local terrestrial coordinates. Also, an analysis of ground shadowing and the shadowing of adjacent collectors was developed. The analysis was developed in sufficient generality to allow direct extension to situations not considered explicitly. For instance, the determination of tracking requirements and rates can be determined for various collector geometries by direct application of this method. Also, more complicated collector shadowing problems, such as those which occur near existing structures, can be analyzed.

8229 (SAND—77-0507C) **Techniques for reducing thermal conduction and natural convection heat losses in annular receiver geometries.** Ratzel, A.C.; Hickox, C.E.; Gartling, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 28p. (CONF-771120—2). Dep. NTIS, PC A03/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, Georgia, USA (27 Nov 1977).

An effective device for the collection of solar energy which has received widespread attention is the so called parabolic-cylindrical solar collector. In this design a circular receiver tube, with a suitable selective coating, is enclosed by a concentric glass envelope and situated along the focal line of a parabolic trough reflector. The heat transfer processes which occur in the annular space between the receiver tube and the glass envelope are important in determining the overall heat loss from the receiver tube. In typical high temperature receiver tube designs the rate of energy loss by combined thermal conduction and natural convection is of the same order of magnitude as that due to thermal radiation, and can amount to approximately 6 percent of the total rate at which energy is absorbed by the solar collector. The elimination of conduction and natural convection losses can significantly improve the performance of a large collector field. Several techniques useful for the reduction of energy loss by thermal conduction and natural convection are considered. The receiver configuration chosen for study is typical of those used in the Solar Total Energy System at Sandia Laboratories. The receiver tube has a "black chrome" selective coating and is 2.54 cm in outside diameter. The inside diameter of the glass envelope is approximately 4.4 cm. Typical operating temperatures of the receiver tube and glass envelope are approximately 300°C and 100°C, respectively.

HEAT STORAGE

REFER ALSO TO CITATION(S) 8206, 8549, 8644

8230 (NP—22422) **Storage of low temperature heat: solar energy thermal storage.** Wettermark, G.; Kowalewska, J. (Tekniska Hoegskolan, Stockholm (Sweden)). Sep 1976. 48p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The major means available for thermal storage of solar energy are reviewed. The general conditions for heat storage are discussed. The various types of sensible and latent heat storage are covered. (MHR)

GEOTHERMAL ENERGY

REFER ALSO TO CITATION(S) 8611

8231 **Alternative energy sources.** Hartnett, J.P. (ed.). New York; Academic Press (1976). 335p.

Ten chapters are included. Separate abstracts were prepared for each. (MHR)

RESOURCE STATUS AND ASSESSMENT

REFER ALSO TO CITATION(S) 8613

USA

8232 **Geothermal power utilization, present and future.** Jonsson, V.K. (Univ. of Iceland, Reykjavik). pp 279-324 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

The geology of Iceland and the chemistry of its thermal waters are described. Multipurpose uses of geothermal energy, current and prospective, are discussed. These are a diatomite plant, greenhouses, fish farming, seaweed drying, freeze drying, the Reykjanes salt plant, the magnesium project, heavy-water production, and recreational and health applications. Geothermal power generation is discussed under such headings as: power plants, material selection, power cycles, and operation of power plants. The district heating system in Iceland is discussed in the following areas: utilization of natural heat in Reykjavik, the district heating system equipment, operating conditions and costs, the proposed Nesjavellis project, and district heating in other parts of Iceland. (MHR)

NON-USA

8233 (STU—74-6596) **Preliminary study of the utilization of geothermal energy.** Wesslen, A.; Agerstrand, T.; Cliffordsson, L.; Gustavsson, G.; Nilsson, K.; Soederlund, G.; Wahlgren, T. (Viak AB, Vaellingby (Sweden)). May 1976. 97p. (In Swedish). Dep. NTIS (US Sales Only), PC A08/MF A01.

Increased interest in new energy sources has lead to more detailed research in the geothermal energy field in Sweden. The following areas are considered: geological conditions, boreholes, water temperature, effect of climatic conditions in Sweden, chemical and physical properties of geothermal water, costs and future developments.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

8234 **Extraction of heat from magmas based on heat transfer mechanisms.** Hardee, H.C.; Larson, D.W. (Sandia Labs., Albuquerque, NM). *J. Volcanol. Geotherm. Res.;* **2**: No. 2, 113-144(Jul 1977).

Analytical heat transfer calculations are used to relate geological surface evidence to conditions that should exist in magma chambers for the purpose of improving estimates of possible commercial heat extraction rates. These calculations indicate that an upward-melting magma system necessarily is approximately equidimensional and that injected magmas with very high aspect (L/D) ratios are likely formed by a forced intrusion process which involves little if any melting or natural convection. Calculations along with

surface heat flow measurements suggest that steady-state heat extraction rates for emplaced heat exchangers in currently suspected shallow magma chambers will probably be below 10 kW m^{-2}, a value that is low by engineering standards.

8235 Heat and mass transfer in the Earth. Simmons, G. (Massachusetts Inst. of Tech., Cambridge). pp 245-278 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

The problem of energy and mass transfer in the earth is phrased in physical terms, in mathematical terms, in engineering terminology, and in the descriptive language of geology. In properties of materials, terms are defined, representative values given, and additional sources of information indicated. Other discussions are included on heat transfer by conduction, heat and mass transfer by convection in permeable media, some geologic considerations, and a dynamic model for geothermal systems. (MHR)

USA

8236 (PB—268421) **Earthquake surveys of the Roosevelt Hot Springs and the Cove Fort areas, Utah. Volume 4. Final report.** Olson, T.L.; Smith, R.B. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Oct 1976. 94p. NTIS PC A05/MF A01.

Forty-nine days of earthquake monitoring around the Roosevelt Hot Springs KGRA during 1974 and 1975 indicates little earthquake activity and no correlation with the Hot Springs area. Marked earthquake activity, however, was located 25 km east within the Cove Fort-Sulphurdale KGRA. A total of 163 earthquakes were located from the two surveys. Focal depths for the Cove Fort area were shallow with 75% of the activity less than 5 km in depth. The maximum calculated depth was 16 km. Composite fault plane solutions in the Cove Fort area showed normal faulting with generally east-west trending T-axes. A high b-value of 1.27 and a statistical analysis using the Kolomogorov model of event occurrence imply swarm-like activity near Cove Fort. Consistently positive P-wave residuals of up to 0.10 sec and detectable S-wave attenuation of ray paths across the Mineral Range are suggestive of the possibility of an upper-crustal zone of high attentuation that is perhaps related to the source of heat of the Roosevelt Hot Springs KGRA.

NON-USA

8237 Hydrogeological and geophysical investigations of a geothermal anomaly in Hungary. II. Geothermal flow system in the Tiszakecske region. Alfoldi, L.; Erdelyi, M.; Galfi, J.; Korim, K.; Liebe, P. (Research Inst. for Water Resources Development, Budapest). *Hydrol. Sci. Bull.;* **21**: No. 2, 301-313(Jun 1976).

The thermal water reservoir system which was developed by boreholes in recent years around Tiszakecske and Lakitelek was subjected to intense investigation. The study confirmed and extended the knowledge of the geothermal anomaly revealed previously in Part I (Alfoeldi and Galfi, 1966). The development of this warm water geothermal field was carried out through 10 exploratory and extension wells. Their depths ranged from 250 to 2,048 m and penetrated a sedimentary sequence of Quaternary-Pliocene-Miocene age. The areal extent of the study area is approximately 150 km^2. Two thermal water reservoir systems can be distinguished: an upper formation consisting of sand and gravel of Quaternary age and a deeper formation including a sand series of Pliocene age. In analyzing the major reservoir parameters and pressure-volume-temperature (PVT) relations and considering the geological conditions, a communication between the two reservoir systems may be supposed. The local, near-surface geothermal anomaly is due to ascending, relatively warm water from the deeper thermal water layer under special geological, hydrodynamic and thermodynamic conditions. By comparison, in the southern part of the study area, a negative geothermal anomaly was found influenced by the descending cold water of meteoric origin.

8238 ^{14}C-age of a sediment in Aso volcano ^{14}C-ages of the quaternary rocks associated with the geothermal activity in Japan. Ota, R.; Kamitani, M.; Ueki, Y. *Chishitsu Chosasho Geppo;* **27**: No. 4, 223-224(1976). (In Japanese).

The carbon-14 age of a carbonaceous sediment, unconformably resting upon a clay bed of 2m+ thick on altered Yunotani Volcanics and being covered by recent volcanic ash, is 970 +- 90 years.

8239 Fission-track ages of the volcanic rocks in Oyasu—Doroyu geothermal field, Akita prefecture: fission-track age of the igneous rocks associated with geothermal activities in Japan. I. Nishimura, S.; Taniguchi, M.; Sumi, K. *Chishitsu Chosasho Geppo;* **27**: No. 11, 713-720(1976). (In Japanese).

Four new fission-track ages were obtained on zircons from volcanic rocks in Oyasu-Doroyu geothermal field, Akita prefecture. They are: KNF 1, Oyu formation, dacite welded tuff, 2.1 m.y.; KNF 2, Kabutoyama dacite, dacite welded tuff, 0.32 m.y.; KNF 4, Takamatsudake andesite, andesite lava, 0.20 m.y.; and KNF 5, Kabutoyama dacite, dacite pumice tuff, 0.34 m.y. The ages of 0.20 to 0.32 m.y. (middle to late pleistocene) from KNF 2, 4 and 5 contribute to the chlonology of the dacitic volcanic formations which are overlain by pleistocene cone volcanoes and are widely distributed in the backbone ranges of northeastern Honshu. The age of 2.1 m.y. (pliocene) from KNF 1 is contradictory to the age of Oyu formation which is assumed to be miocene from the assemblage type of plant fossils. Further studies on the dating and/or stratigraphy are required.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

8240 (CONF-7506170—1) **Attempt at correlating Italian long lineaments from LANDSAT-1 satellite images with some geological phenomena. Possible use in geothermal energy research.** Barbier, E.; Fanelli, M. (Consiglio Nazionale delle Ricerche, Pisa (Italy). Istituto Internazionale per le Ricerche Geotermiche). 1975. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From NASA earth resources survey symposium; Houston, Texas, USA (Jun 1975).

By utilizing the images from the American satellite LANDSAT-1, in the spectral band 0.8 to 1.1 μm (near infrared), a photomosaic was obtained of Italian territory. From this mosaic the field of long lineaments was drawn, corresponding to fractures of the earth's crust more than 100 km long. The authors have therefore verified the relationship between lineaments, hot springs, volcanic areas and earthquake epicenters. There is a clear connection between long lineaments and hot springs: 78% of the springs are located on one or more lineaments, and the existence of "hot lineaments" was observed. A slightly weaker, but still significant, connection exists between the Pliocene-Quaternary volcanic areas and long lineaments. The relationship between earthquakes and long lineaments can only be verified in some cases. The lineaments which can be related to earthquakes have little or no connection with the other phenomena. Results obtained by the authors could widen the possibility of using satellite images in the field of applied research.

8241 (NP—22303) **Seismic control during a reinjection experiment in the Viterbo region (central Italy).** Cameli, G.M.; Carabelli, E. (Ente Nazionale per l'Energia Elettrica, Pisa (Italy). Centro di Ricerca Geotermica; Politecnico di Milano (Italy). Istituto di Geofisica Applicata). 1975. 13p. Dep. NTIS (US Sales Only), PC A02/MF A01.

In connection with a reinjection experiment in the Viterbo region a seismic control program was executed before, during, and after the reinjection. The gravity flow of water into the well lasted nine days with a rate ranging from 3.5 to 35.5 liters/sec. Seismic surveys were performed continuously. The background noise level during the night is 10 to the minus 5 cm/sec while during the day it is more than 10 to the minus 3 cm/sec due to human activity. A wide range of noises of both natural and anthropogenic sources were recorded and classified as to frequency, amplitude and period. Analysis of the characteristics and recording results showed that seismic or microseismic events caused by hydrocracking related to fluid injection had occurred.

8242 (PB—268423) **Gravity and ground magnetic surveys of the Central Mineral Mountains, Utah. Volume 6. Final report.** Crebs, T.J.; Cook, K. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Dec 1976. 149p. NTIS PC A07/MF A01.

During the summers of 1974 and 1975, gravity and ground magnetic surveys were made over the central part of the Mineral Mountains and vicinity, Utah. The gravity survey comprised 627 gravity stations over an area of approximately 660 sq km, and included 8 gravity profiles over the Roosevelt Hot Springs KGRA. The magnetic survey comprised over 400 magnetic stations within 4 magnetic profiles. The gravity data were compiled as a terrain-corrected Bouguer gravity anomaly map with a contour interval of 2 mgal. The gravity features include: (1) generally northward-trending gravity contours with gradients along the margins of the Mineral Range, indicating that the range is a horst bounded on the east and west by the Beaver and Milford valley grabens, respectively, where the Milford Valley graben shows pronounced gravity low, which indicates a valley-fill thickness of about 1.8km; and (2) a northward-trending gravity high extends along the western flank of the Mineral Range (probably caused by high-density metamorphic rocks).

8243 (USGS-OFR—77-65B) **Audio-magnetotelluric data log and station location map for Baltazor Known Geothermal Resource Area, Nevada.** Long, C.L.; Senterfit, M. (Geological Survey, Reston, Va. (USA)). 1977. 6p. TIC.

The observed apparent resistivity in ohm-meters is tabulated for each of the 16 stations. The frequencies ranged from 7.5 to 18.600 Hz. A station location map is also included. (JGB)

EXPLORATORY DRILLING AND WELL LOGGING

8244 (NP—22326) **Attainment of temperature equilibrium in holes during drilling.** Manetti, G. (Ente Nazionale per l'Energia Elettrica, Pisa (Italy). Centro di Ricerca Geotermica). 1976. 23p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A fitting function for time-temperature curves of deep wells was proven. It yields a sufficient (2 to 3 percent) accuracy in extrapolation at temperature equilibrium values. The function is based on the study of thermal transients consequent upon disturbances induced by drilling operations. Analyses were undertaken based on thermometric data from a ten year period, from shallow geothermal holes. The results show that a three parameter logarithmic law can be used to interpret the asymptotic behavior. Extrapolation can be performed from short (20 to 30 hr) measuring times using a function of the asymptotically logarithmic type and involving a four parameter relation of the integral exponential function.

8245 (PB—268422) **Thermal gradient and heat flow drilling. Volume 5. Final report.** Whelan, J.A. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Jan 1977. 55p. NTIS PC A04/MF A01.

During the summer of 1975, the Department of Geology and Geophysics drilled nine drill thermal gradient/heat flow holes. Total footage drilled was 2125 feet. Seven holes were drilled with a Mayhew 1000 drill using various combinations of down the hole hammer drilling, rotary drilling, and NX diamond core drilling. Three of these were heat flow holes--one in the Mineral Range, one in the Tushar Range near Beaver, Utah, and one near Monroe, Utah. Two were alteration study holes in the Roosevelt KGRA and two were temperature gradient holes, in alluvium in the Roosevelt KGRA. The average depth of the holes drilled with the Mayhew 1000 drill was 247 feet. Holes ranged from 135 feet to 492 feet. Cost per foot averaged $18.53. Two holes were core drilled with a Joy 12, BX-size drill. One was to 75 feet, in perlite. This hole was abandoned. The other was to 323 feet in granite.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 8241

8246 (NP—22316) **Reinjection experiment in the Vico 1 well.** Calamai, A.; Ceron, P.; Ferrara, G.C.; Manetti, G. (Ente Nazionale per l'Energia Elettrica, Pisa (Italy). Centro di Ricerca Geotermica). 1976. 3p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Environmental protection is becoming an increasingly pressing issue in Italy. To study the problem of effluent disposal in the area of geothermal exploitation a series of experiments was planned. These experiments will ascertain the receptive capacity of the carbonate formations which, in Italy, generally represent the reservoir of endogenous fluids. They will attempt to detect the flow patterns of reinjected fluids and their influence on recharge, and will try to determine whether or not seismic activity may result from the fluid injection. The first experiment is described and preliminary results are mentioned.

8247 (PB—268289) **Environmental assessment of geopressured waters and their projected uses. Final report.** Wilson, J.S.; Hamilton, J.R.; Manning, J.A.; Muehlberg, P.E. (Dow Chemical Co., Freeport, Tex. (USA)). Apr 1977. Contract EPA-68-02-1329. 99p. NTIS PC A05/MF A01.

A possible source of alternate energy for the nation is believed to exist in the deep geopressured reservoirs found in the Texas and Louisiana Gulf Coast sedimentary basins. This report considers the potential uses of the geopressured geothermal resource and the environmental aspects of those uses. Economics of power production are estimated as an aid to assignment of priority research and development in the area. Principal environmental impacts of any of the proposed uses will result from the waste fluid streams and from possible subsidence of the wellfield. In most instances, disposal of this large volume of saline fluid will require reinjection, canaling to a saline water body, or some more imaginative method. The area is one of natural subsidence which may be accelerated by deep fluid withdrawal. This report describes the resource, the possible uses, the projected resulting emissions, other impacts upon the land, the present stage of development, and projections of future developmental plans.

8248 (USGS-OFR—77-249) **Potential for triggering of earthquakes by stimulation of dry rock geothermal fields.** Raleigh, C.B. (National Center for Earthquake Research, Menlo Park, Calif. (USA)). 1977. 5p. TIC.

Stimulation of dry geothermal fields requires the injection of very large volumes of fluid, probably at pressures in excess of the least principal stress in the rocks. The high fluid pressure, if transmitted along faults under shear stress would reduce sigma/sub n/, the effective normal stress, and hence the frictional resistance to sliding along the fault. Earthquakes triggered by water flooding in the Rangely oil field in Colorado are discussed. Calculations indicate that earthquakes are likely to be triggered by fluid injection where the injection pressure is at or near the magnitude of the least principal stress. (JGB)

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 8232

POWER PLANT SYSTEMS AND COMPONENTS

8249 (SAN/1116—1) **Geothermal direct contact heat exchange. Final report.** Sims, A.V. (Holt (Ben) Co., Pasadena, Calif. (USA)). 10 Jun 1977. Contract EY-76-C-03-1116. 115p. Dep. NTIS, PC A06/MF A01.

A glass direct contact heat exchange column was operated in the laboratory. The column was operated at atmospheric pressure using hot water and normal hexane. Column internals testing included an empty column, sieve trays, disk-and-doughnut trays, and two types of packing. Operation was very smooth in all cases and the minimum temperature approaches varied from less than 1°C for packing to 13°C for the empty column. High heat transfer rates were obtained in all cases, however, columns should be sized on the basis of liquid and vapor traffic. The solubilities of hydrocarbons were determined for normal hexane, pentane and butane in water and sodium chloride and calcium chloride brines at various temperatures. The values seem to be internally consistent and salt content was found to depress hydrocarbon solubility. Laboratory stripping tests showed that gas stripping can be used to remove hydrocarbon from reject hot water from the direct contact heat exchange column. Although the gas volumes required are small, stripping gas requirements cannot be accurately predicted without testing. A computer program was used to study the effect of operating variables on the thermodynamic cycle efficiencies. Optimum efficiencies for the moderate brine conditions studied were obtained with isopentane as working fluid and relatively low operating pressure. A preliminary design for a 50 MWe plant was prepared and plant capital cost and operating cost were estimated. These costs were combined with previously developed brine production and power transmission costs to provide an estimate of the cost of delivered power for a geothermal field at Heber, California. A pilot plant program is described that would be suitable for continuing the investigation of the direct contact process in the field. The program includes a suggested schedule and the estimated cost.

8250 **Power generation from hot brines.** Sheinbaum, I. US Patent 3,988,895. 2 Nov 1976. Filed date 11 Jan 1974. 8p.

Hot fluid which may contain salts and other dissolved minerals is passed through a direct contact heat exchanger in heat exchange relationship with a working fluid that has a specific gravity sufficiently below the specific gravity of the fluid so that it may pass from the bottom to the top of the heat exchanger chamber in contact with the fluid. The pressure of the chamber is selected to provide a certain mixture of working fluid and hot fluid at the output of the power extracting device of the system. The working fluid is selected so that the salts and other minerals in the fluid are relatively insoluble therein. The working fluid is vaporized in the exchanger and the vaporized working fluid and any steam mixed therewith are passed through a power extracting gas expansion device. The working fluid is separately condensed and recirculated.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

8251 **Method of foam drilling using a sulfoacetate foaming agent.** Fischer, P.W.; Pye, D.S. (to Union Oil Co. of California). US Patent 4,036,764. 19 Jul 1977. Filed date 14 Oct 1975. vp.

A method is described of conducting foam drilling and workover operations in a borehole penetrating a subterranean formation, particularly a high-temperature formation such as a geothermal formation. An aqueous solution of a foaming agent is employed. A particularly preferred foaming agent is sodium lauryl sulfoacetate.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 8244

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

8252 **Production of hot brines from liquid-dominated geothermal wells by gas-lifting.** Carlson, E.; Gunkler, A.A.; Miller, C.O.M.;

Paalman, H.H. (to Dow Chemical Co.). US Patent 4,017,120. 12 Apr 1977. Filed date 28 Nov 1975. 10p.

Hot brines containing dissolved gases are produced from liquid-dominated geothermal wells by utilizing lift gases of essentially the same composition as the dissolved gases. The lift gas is separated from the produced brine and recycled. Heat is abstracted from the separated brine, which may be returned to the aquifer, processed for its mineral content or discarded. The gas lift is carried out under temperature and pressure conditions such that precipitation of minerals from the brine does not occur in the well bore. The problems which would result from the use of oxygen-containing and/or brine-soluble inert gases for the lifting operation are avoided. The problems attendant upon production of hot brines by pumping are also avoided.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 8232

8253 (NP—22082) **Potential for heating western tree seedling greenhouses with geothermal energy.** McDonald, S.E.; Austin, C.F.; Lott, J.R. (Forest Service, Missoula, Mont. (USA). Equipment Development Center). Nov 1976. 20p. Forest Service, Fort Missoula, MT.

The technology to apply geothermal energy to greenhousing is available. Geothermal energy is compatible with greenhouse heat exchange hardware, and it is abundant in the western United States. Geothermal resources suitable for greenhousing are natural springs, deep hot water or steam wells, and waste water from electrical power generating plants. Factors influencing greenhouse heating needs include climate, elevation, structure, and growing regime, as well as the attributes of the geothermal energy source: heat, quantity, quality. Greenhouse sites should be evaluated for suitability, size, availability of labor supply, markets, etc. Problems exist in developing any new energy source, but a sound economic assessment based on good engineering and geological advice will illustrate advantages and problems. When considering geothermal energy as an alternative energy source these steps are recommended: (1) Determine the geographic region greenhouse will serve. (2) Tabulate known geothermal resources within region. (3) Rank potential locations in terms of geothermal fluid chemistry and location. (4) Obtain data on chemistry, flow potential, temperature, and probable lifespan of resources. (5) Conduct economic analysis of proposed greenhouse operation using these geothermal sources; compare with optimum fossil fuel economics and long term availability in the region. (6) Proceed with project if economically attractive.

GEOTHERMAL DATA AND THEORY

REFER ALSO TO CITATION(S) 9125

PROPERTIES OF AQUEOUS SOLUTIONS

8254 (USGS-OFR—77-214) **Volumetric properties of vapor saturated aqueous potassium hydroxide solutions from 0° to 400° and vapor saturated aqueous sodium hydroxide solutions from 0° to 350° based on a regression of the available literature data.** Brown, D.L.; Potter, R.W. II. (Geological Survey, Reston, Va. (USA)). 1977. 12p. TIC.

Pressure-volume-temperature-composition (P-V-T-X) data for brines are required to establish optimum operating conditions for the production of geothermal brine fields; to minimize scaling and corrosion; and to intelligently design turbines for production of electricity. An internally consistent set of density values is tabulated for vapor-saturated, aqueous potassium hydroxide solutions from 0°C to 400°C and for vapor-saturated, aqueous sodium hydroxide solutions from 0°C to 350°C based on the currently available experimental data. (JGB)

8255 (USGS-OFR—77-215) **Volumetric properties of vapor saturated aqueous HCl solutions from 0° to 100°C, vapor saturated aqueous $FeCl_2$ solutions at 15° and 18°C, and vapor saturated aqueous $FeCl_3$ from 0° to 35°C based on a regression of the available literature data.** Brown, D.L.; Potter, R.W. II. (Geological Survey, Reston, Va. (USA)). 1977. 14p. TIC.

Pressure-volume-temperature-composition (P-V-T-X) data for brines are required to establish optimum operating conditions for the production of geothermal brine fields. Precise thermodynamic data derived from the volumetric properties of the brines are prerequisite for chemical and reservoir modeling of geothermal brine systems. A compilation of density values is presented therein for vapor-saturated hydrochloric acid of 0 to 40 weight percent concentrations from —5°C to 100°C, for aqueous vapor-saturated ferrous chloride of 0 to 35 weight percent concentrations at 15°C and 18°C, and for aqueous vapor-saturated ferric chloride of 0 to 50 weight percent concentrations from 0°C to 35°C. (JGB)

ROCK-WATER-GAS INTERACTIONS

8256 **Stability of the magnesium carbonate ion pair from 10 to 90°C.** Siebert, R.M. (Univ. of Missouri, Columbia); Hostetler, P.B. *Am. J. Sci.;* **277**: No. 6, 716-734(Jun 1977).

The dissociation constants of the aqueous $MgCO_3^0$ ion pair were determined experimentally from 10 to 90°C at 15° intervals. Absolute pH measurements in $MgCl_2$—$KHCO_3$ solutions being titrated with K_2CO_3 were used to calculate the results. The experimental pK/sub $MgCO_3^0$/ (-log K/sub dissociation/) at 25°C is 2.98 +- 0.03, and the pK values rise smoothly, as a function of temperature, to a value of 3.41 +- 0.067 at 90°C. The temperature variation is in excellent agreement with that predicted by electrostatic ion pair theory. The derived values of $\Delta G/^{\circ}$, $\Delta H/^{\circ}$, and $\Delta S/^{\circ}$ of dissociation at 25°C are 17050 +- 125 J mol^{-1} (4075 +- 30 cal mol^{-1}, -8439 J mol^{-1} (-2017 cal mol^{-1}), and -85.48 J deg^{-1} mol^{-1} (-20.43 cal deg^{-1} mol^{-1}), respectively.

ISOTOPE AND TRACE ELEMENT STUDIES

8257 **Correlation of Mg/Fe partitioning between garnet and biotite with $^{18}O/^{16}O$ partitioning between quartz and magnetite.** Goldman, D.S.; Albee, A.L. (California Inst. of Tech., Pasadena). *Am. J. Sci.:* **277**: No. 6, 750-767(Jun 1977).

Isotopic and chemical data for thirteen metamorphic rocks containing garnet and biotite are used to investigate the dependence of the Mg—Fe partition upon temperature, expressed as the $^{18}O/^{16}O$ fractionation between quartz and magnetite, and upon chemical variation in both phases. Additional sets of samples considered to have equilibrated at nearly the same temperature are utilized to improve the least-squares solution of the compositional coefficients. The most acceptable least-squares solution, using the singular-value decomposition algorithm, is: K/sub D//sup Mg-Fe//sub G-B/ = - 0.177(+-0.010)1000 ln/sub α//sup Q//sub M/ - 1.22(+-0.14)X/sup G//sub Mn/ - 2.14(+- 0.13)X/sup G//sub Ca/ + 1.40(+- 0.09)X/sup B//sub Fe/ + 0.942(+- 0.109)X/sup B//sub Ti/ - 1.59(+- 0.21)X/sup B//sub Al/sup vi// - 0.492(+- 0.068). K/sub D/ is primarily dependent upon temperature but is also dependent upon compositional variation, particularly upon X/sup B//sub Fe/, although X/sup G//sub Ca/ becomes significant at higher concentrations.

8258 **Partition of Al, Mg, and Si between coexisting Ca-rich, and Ca-poor pyroxenes.** Hirano, H. (Geological Survey of Japan, Tokyo); Matsumoto, T. *Geochem. J. (Nagoya);* **10**: No. 1, 33-41(Mar 1976).

Partition of Al, Mg and Si in coexisting Ca-rich and Ca-poor pyroxenes is expressed by the equation: $Mg_2Si_2O_6$/sup Opx/ + $CaAl_2SiO_6$/sup Cpx/ = $MgAl_2SiO_6$/sup Opx/ + $CaMgSi_2O_6$/sup Cpx/. Enthalpy and volume differences in the reaction were estimated on the basis of available high-temperature experimental data and unit-cell parameters of the pyroxene solid solutions. From the thermodynamic data and the calculation of the apparent distribution coefficient for natural pyroxene pairs of various modes of occurrence, the following conclusions were obtained: (1) The apparent distribution coefficient depends on the Fe/Mg ratio of pyroxene as well as equilibration temperature. (2) The normalized apparent distribution coefficient can be used as a geothermometer. (3) The distribution coefficient, K/sub Al/(=(/sup Z/Al/Si)/sup Cpx//(/sup Z/Al/Si)/sup Opx/) may not be an appropriate geobarometer.

8259 **Thermodynamic interpretation of Na—K—Ca geothermometer in the natural water system.** Shikazono, N. (Tokyo Univ.). *Geochem. J. (Nagoya);* **10**: No. 1, 47-50(Mar 1976).

A cation-chloride concentration diagram showing the stability of minerals in natural water system at elevated temperatures is constructed. The curves on this diagram showing the equilibrium between aqueous solution and minerals commonly occurring in nature generally satisfy the empirical Na-K-Ca relationship obtained by Fournier and Truesdell (1973). This indicates that the chemical composition of natural waters is largely controlled by minerals commonly occurring in nature.

TIDAL POWER

REFER ALSO TO CITATION(S) 8613

WIND ENERGY

REFER ALSO TO CITATION(S) 8611, 8613

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

8260 (N—77-21467) **100-kW metal wind turbine blade: basic data, loads, and stress analysis. Final report.** Cherritt, A.W.; Gaidelis, J.A. (Lockheed-California Co., Burbank (USA)). Jun 1975. Contract NAS3-19235. 241p. (NASA-CR—134956; LR—27153). NTIS PC A11/MF A01.

A rotor loads computer program was used to define the steady state and cyclic loads acting on 60 ft long metal blades designed for the ERDA/NASA 100 kW wind turbine. Blade load and stress analysis used to support the structural design are presented. For the loading conditions examined, the metal blades are structurally adequate for use, within the normal operating range, as part of the wind turbine system.

8261 (N—77-21468) **100-kW wind turbine blade: dynamics analysis, weight-balance, and structural test results. Final report.** Anderson, W.D. (Lockheed-California Co., Burbank (USA)). Jun 1975. Contract NAS3-19235. 102p. (NASA-CR—134957; LR—27230). NTIS PC A06/MF A01.

The results of dynamic analyses, weight and balance tests, static stiffness tests, and structural vibration tests on the 60-foot-long metal blades for the ERDA-NASA 100-kW wind turbine are presented. The metal blades are shown to be free from structural or dynamic resonance at the wind turbine design speed. Aeroelastic instabilities are unlikely to occur within the normal operating range of the wind turbine.

8262 (PB—268718) **Wind energy conversion. Final report, Feb 1975—Oct 1976.** Miller, R.H.; Martinez-Sanchez, M.; Dugundji, J.; Larrabee, E.E.; Chopra, I. (Massachusetts Inst. of Tech., Cambridge (USA). Aeroelastic and Structure Research Lab.). Oct 1976. 431p. (ASRL-TR—184-3). NTIS PC A19/MF A01.

An investigation is made of various problems associated with the design of horizontal axis, low solidity, high performance wind turbines. The report deals with the following topics: (a) Wind turbine performance as determined from various elementary and more refined momentum theories; (b) Performance trade-offs between constant RPM and constant velocity ratio operation; (c) Aerodynamic vortex theories for blade loadings including unsteady effects and wind shear velocity gradients; (d) Control dynamics of a synchronous alternator-wind turbine system; (e) Linear aeroelastic stability studies of rotor blades in the presence of moderate initial coning angles; (f) Nonlinear dynamic response of rotor blades including gravity and wind shear excitation; (g) An experimental investigation of a .914 m (3 ft) diameter, 2 bladed wind turbine placed in a wind tunnel.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 8197

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 8604

8263 **Investigation of typical capacity control circuits for 300 mw monoblocks using electronic models.** Sitnitskii, Yu.I.; Simkin, B.E. (L'vov Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 3, 67-73(Mar 1977). (In Russian).

Results of comparative tests of two variants of typical automatic power control circuits for 300 MW monoblocks with a TGMP-314 steam generator and a K-300-240 turbine under a load of 260 MW, are presented. These tests were carried out on the electronic modeling machine, MPT-9. Appropriate conclusions are drawn.

8264 **Design, construction, testing, and operation of a large scale prototype desalting plant in Israel.** Barak, A.Z. (National Council for Research and Development, Jerusalem); Barnes, W.L. *Desalination;* **20**: No. 1/2/3, 163-172(Mar 1977).

The various aspects of the joint U.S.-Israel desalting project for the design, construction and operation of a 10 mgd multiple-effect dual purpose plant are described. The background, the plan and the scope of the project are detailed as well as the characteristic features, advantages and disadvantages of the IDE process which is incorporated in the project. A forecast of the future activity in Israel concerning the use of this MED Process following this project is briefly outlined. Finally, a normalized cost evaluation of desalted water produced in similar plants is presented.

8265 **Water and power installation for Lanzarote (Canary Islands) Spain.** Krebs, F. (Babcock and Wilcox, Espanola SA, Madrid). *Desalination;* **20**: No. 1/2/3, 173-191(Mar 1977).

Water producing and electrical generating facilities had to be increased on the Spanish Canary Island of Lanzarote for it to develop beyond its 1972 status. The Ministry of Public Works, prepared specifications for a turnkey installation of two 2500 M^3/D desalting plants and a 5 MW (net) generating system. In 1973 through international competition Babcock and Wilcox, Espanola won a contract to build the installation. In December 1975 the construction of the project was completed. In early January 1976 the first line was producing 103% of the rated production at a thermal efficiency of 120% of the rated value. The second line was modified to operate at a reduced maximum brine temperature and commissioned. This plant was brought to full production which was 115% of the rated production in $2^1/_2$ days. Problems and delays during the commissioning, were minimal. A 5 days performance test of the installation was run. During this test the water production was $111^1/_2$% of the rated value at a specific energy consumption of 93% of the rated value while the maximum brine temperature was maintained 6°C less than the design value. The high performances were achieved because the plants were well designed and built and properly commissioned. During the first $4^1/_2$ months that the owner operated the installation it provided water and power as demanded. During that time the average plant production was 107% of the rated capacity.

8266 **Dual purpose power/water plants utilizing both distillation and reverse osmosis.** Hornburg, C.D.; Cruver, J.E. *Desalination;* **20**: No. 1/2/3, 27-42(Mar 1977).

The energy consumption of several alternate dual purpose plants are compared for application in the range of 10 to 50 MW with 1 to 20 MGD water production. This shows that the combined gas turbine-steam turbine system is considerably more energy efficient than a steam only system. Single state reverse osmosis (RO), used in conjunction with this combined cycle, offers the minimum overall energy consumption but has the disadvantage of producing product water with high TDS. By utilizing both RO and distillation, energy consumption lower than with distillation alone is achieved and product water purity is acceptable. A specific design of a combined dual purpose plant is presented. This plant would have a net electrical output of 29,050 kw and 3.25 MGD of 440 ppM TDS, requiring 297.1 BTU/hr. The total capital costs of this combined plant is estimated at $41,150,000 and annual operating costs at $15,087,000. The unit production costs with fuel at $2.50/MM BTU would be 4.08 cents/kw-hr and $2.44 per 1000 gal. This represents an annual savings of $1,961,000 over single purpose production or 44.5% reduction in water production costs with the same electrical production costs. It is concluded that the combined dual purpose plant presented is the most efficient, economical and flexible method of producing power and water in the range of 10 to 50 MW and 1 to 20 MGD.

8267 **Stabilization of the process of fuel supply to a multiple-fuel diesel-generator working on gasoline.** Kornilov, V.V. (Riga Disel Plant, Latv, SSR). *Energomashinostroenie;* No. 4, 37-39(1977). (In Russian).

Based on experiments, a method of stabilization of the process of fuel supply by using reduced-tightness delivery valves is proposed. Empirical formulas are presented permitting determination of the character of the process when working on gasoline by means of data about the hydraulic characteristics of the atomizer and the magnitude of the diametral gap around the discharge band of the delivery valve.

8268 **Automation in the energy production process. Tasks of the guidance technique.** Weidemann, H. (Hartmann und Braun A.G., Frankfurt am Main (Germany, F.R.)). *Elektrische Energie-Tech.;* **21**: No. 18, 372-375(Sep 1976). (In German).

6 figs.

The task of the industrial process is to produce something with constantly good and permanent quality with regard to official provisions and using the highest plant profitability. The total system conception is given its first limits by the safety and environmental provisions; further limits are set by technologies and the techniques available. A part of the total system is the automation system which is the guidance system for the process.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

8269 (BNWL—2180(Vol.2)) **User's manual for the BNW-I optimization code for dry-cooled power plants.** Braun, D.J.; Braun, D.J.; De Mier, W.V.; Faletti, D.W.; Wiles, L.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 176p. Dep. NTIS, PC A09/MF A01.

This appendix provides a listing of the BNW-I optimization code, MFCIRI, for a metal finned tube dry-cooled heat rejection system for power plants. (LCL)

8270 (PB—267945) **Field investigations of mechanical draft cooling tower plumes.** Winiarski, L.D.; Frick, W.F. (Environmental Protection Agency, Corvallis, Oreg. (USA). Corvallis Environmental Research Lab.). Mar 1977. 68p. (EPA—600/7-77/025). NTIS PC A04/MF A01.

Tethered Kitoon (small blimp) sampling techniques were devised to measure the distribution of temperature and humidity in the invisible portion of power plant cooling tower plumes from both single cell and multiple cell cooling towers under several conditions. These measurements, together with data collected on the ambient meteorology and exit plume conditions, are particularly useful in moist plume modeling work.

POWER CYCLES

8271 (CONF-770402—6) **Comparative evaluation of technical and economic indices for MHD and thermionic toppers for steam turbine facilities. US—USSR cooperative program in MHD power generation.** Morozov, G.N. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Magnetohydrodynamics). 1977. 19p. Dep. NTIS, PC A02/MF A01.

From The US-USSR Steering Committee for cooperation in MHD; Washington, District of Columbia, United States of America (USA) (13 Apr 1977).

To attain high efficiency in steam turbine (ST) facilities it is necessary to simultaneously increase the temperature and the pressure of the super heated steam. This is technically very difficult because of the low strengths of structural materials at high temperatures. One of the possible and evidently most promising ways of avoiding the simultaneous effect on the equipment of high temperature and high pressure is to have the steam cycle augmented by a high temperature cycle operating with a relatively low pressure of working fluid. Two types of high temperature toppers are considered (thermionic energy converters (TEC) and MHD generators (MHDG)) and on the basis of a comparative analysis an evaluation is made of their technical and economic indices. The following types of power plants operating with gas are compared: (1) with ST; (2) with TEC and ST; (3) with MHDG and ST; and (4) with MHDG, TEC and St.

8272 (MIT—2295-1) **Combined cycle research program. Quarterly technical progress report (No. 1), July 1—September 30, 1976.** Louis, J.F.; Topping, R.F. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Oct 1976. Contract EX-76-C-01-2295. 22p. Dep. NTIS, PC A02/MF A01.

Fossil fueled, gas turbine-steam turbine combined cycle power plants are thought by many experts to be the most practical and efficient choice for next generation electric power production. The major benefits of this combined cycle system are the potential attainment, at relatively low risk and development cost, of high efficiencies while maintaining pollutant emissions within environmental specifications. The industrial gas turbine is not without its development problems, however. Research is needed in turbine cooling, turbine materials corrosion and fuel gas clean up. While separate disciplines in themselves, they all closely interrelate in determining allowable turbine operating temperature and overall cycle performance. MIT has been commissioned by the US ERDA to undertake some essential work for the future development of combined cycle power plants. This three year research program deals with critical problems related to combined cycles; turbine cooling with air and water, materials corrosion and high temperature fuel gas desulfurization. Research in these areas will provide needed data for turbine component design and thus serve as a necessary compliment to the ERDA High Temperature Turbine Technology Program. The effort will also provide corrosion data for other metal and ceramic components and necessary information concerning high temperature desulfurization; as well as providing accurate experimental data for input into, and verification of, the various computer simulator models under development.

COMPONENTS

REFER ALSO TO CITATION(S) 8949

8273 (FE—1765-25) **High temperature gas turbine engine component materials testing program. Task 1. Quarterly technical progress report No. 6, October 1—December 31, 1976.** Cutrone, M.B. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Products Div.). 15 Jan 1977. Contract EX-76-C-01-1765. 77p. Dep. NTIS, PC A05/MF A01.

Eighty-seven hours of initial testing have been completed with H-coal doped creosote. During the last 20 hrs of testing in Oct. 1976, an overtemperature occurred which resulted in nozzle sector damage. The nozzle has been repaired. Metallographic examination of nozzle material confirms overtemperature oxidation but no overall corrosion attack. Only minor sulfidation was observed. Gas particulate sampling measurements were conducted at MERC. A total of 14,500 hours of screening tests have been completed as of Dec. 31, 1976. These data continue to confirm the more corrosive effects of alkali metals in combination.

8274 (FE—1765-34) **High temperature gas turbine engine component materials testing program. Task 1. Quarterly technical progress report No. 8, April 1—June 30, 1977.** Cutrone, M.B. (General Electric Co., Schenectady, N.Y. (USA). Gas Turbine Div.). 15 Jul 1977. Contract EX-76-C-01-1765. 75p. Dep. NTIS, PC A04/MF A01.

Initial liquid tests resumed in May, 1977, using creosote oil doped with H-coal sludge to 150 ppM ash level. Fifty-nine hours of testing were successfully completed at 1950°F firing temperature. Examination of simulator components showed minor deposits, some cooling hole plugging and the presence of alkali. Subsequently, 43h of initial tests were completed with nominal 500 ppM ash level creosote fuel. The test was aborted due to an overtemperature excursion caused by partial loss of combustion air. Hardware damage occurred. Repairs are nearing completion and testing will resume in July. Although aborted, the test has provided a large quantity of on-line data relating to ash deposition. Screening tests continued throughout the quarter. Preparations for confirmation testing continued with fabrication of test hardware and initial checkout of the gasifier/cleanup system.

8275 **State of stress and strain of a blade shroud with rectangular holes.** Salo, V.A.; Groza, V.F. (Khar'kov Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 1, 122-125(1977). (In Russian).

The stress-strained state of the band shroud of steam turbine rotor blades is investigated. Numerical results of the calculation of the shroud with different variants of its geometrical parameter values are presented. Graphs of reduced principal stresses at the hole contour are presented. The elastic surface of the calculated part of the shroud is plotted.

8276 **Determining the higher harmonics of voltages and currents for three-phase dc generators.** Balagurov, V.A.; Ledovskii, A.N.; Sugrobov, A.M. *Elektrichestvo;* No. 2, 66-70(Feb 1975). (In Russian).

Equations are derived for determining current and voltage harmonics taking into account the nonsinusoidality of curves for conductivity changes in the space between teeth. An approach for selecting the tooth geometry with allowance for the requirements for the shape of voltage curve is given. 5 refs.

WASTE HEAT UTILIZATION

8277 (ORNL-tr—4384) **Arrangement of a series of greenhouses in the Ain Plain.** Dumont, M. 8 Jan 1975. Translated from French report, TT/75-1-H/MD. 12p. Dep. NTIS, PC A02/MF A01.

A proposal is presented to realize a 50 hectare zone of greenhouses, using the heat from the dilution water removed by units 4 and 5 of the Bugey power plant, site No. 1. Realization of this 50 hectare zone of greenhouses leads to an annual savings of more than 15,000 tons of imported heavy fuel at the expense of electrical consumption of 25 GWL. The proposal discusses the vegetative products that could be profitably produced in the greenhouses maintained at various temperatures. (MCW)

ECONOMICS

REFER ALSO TO CITATION(S) 8606

FUELS

REFER ALSO TO CITATION(S) 7813, 7903

ENVIRONMENTAL ASPECTS

8278 **More black death than black gold.** Smith, D. *Nucl. Eng. Int.;* **22**: No. 253, 24-25(Feb 1977).

Statistics given in the U.S. Council on Economic Priorities report power plant performance are included. Nuclear and coal capacity factors and economics are presented. The author disagrees with these figures, which indicate that coal-fired power plants have a marked advantage over nuclear plants. He argues that deaths from pit accidents and from pneumoconiosis would be avoided if nuclear power was used, and gives estimates of the cost of fatalities and of environmental degradation from pollution from nuclear and coal-fired power generation.

8279 **Monitoring pollution. Part II: water.** Elliot, T.C. *Power (N.Y.);* **120**: No. 10, S.13-S.24(Oct 1976).

Explains which pollutants should be measured in water in power generation plants, where measurements should be made, and how water samples should be taken. Some pollution monitoring equipment available in the U.S., an automatic pollution monitoring network, and the use of specific ion electrodes are described.

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

8280 (PB—268238) **Compact, in-stack, three size cut particle classifier. Final report, May 1975—Oct 1976.** Lacey, G.E.; Cushing, K.M.; Smith, W.B. (Southern Research Inst., Birmingham, Ala. (USA)). Apr 1977. Contract EPA-68-02-1736. 96p. NTIS PC A05/MF A01.

A compact, in-stack, three size cut particle classifier was designed, fabricated and tested. The classifer consists of a two-stage impactor and back-up filter designed to measure the particulate emissions from sources in three size ranges: greater than 3 micrometers, approximately 1-3 micrometers, greater than 1 micrometer. Three sets of jet plates (two jet plates per set) are included. Each set is designed for a different flow rate; however, all particle size cutpoints produce data in the three size ranges of interest. A choice of flow rates is desirable to allow reasonable sampling times at particulate emission sources with both high and low mass loadings. The classifier was calibrated in the laboratory with monodispe.se aerosols from a vibrating orifice aerosol generator. In field tests at three power plants, particle size distribution by the classifier were compared to particle size distributions by Andersen and Brink samplers. With this compact sampling system, measurements of the three size fractions are possible over a wide range of test conditions.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 8332

8281 **Electrical control room arrangement.** Nowak, K. *Elektrische Energie-Tech.;* **21**: No. 18, 381-384(Sep 1976). (In German). 6 figs.; 2 tabs.

'Electrical Control Room Regulations' have come into force in various parts of Germany. They deal with the constructional arrangements of rooms where certain electrical equipment is situated. This includes transformers and switchgear for rated voltages above 1 KV, fixed power generation equipment, central batteries and other fixed battery equipment. The report details the special qualities of EltBauVO and points out the comprehensive nature of the regulations.

8282 **Losses in liquid nitrogen cooled high intensity cables due to thermal effects under symmetric dc load.** Heller, I. (Kernforschungsanlage Juelich, Ger). *Elektrotech. Z., A;* **96**: No. 7, 297-300(Jul 1975). (In German).

A survey on experimental and theoretical investigations in current induced losses of high power cables is presented. Measurements on compact and tube conductor cable models have been done at room temperature and liquid nitrogen temperature (77°K). Measurements of a 2000 mm^2 segmental conductor and a 2325 mm^2 fully transposed litz conductor have been performed. Using the experimental results published, calculation methods have been tested with regard to the applicability at very large conductor cross section or high conductivity. If necessary, improvements of the calculation methods are suggested.

8283 **Almhoflex: a new aluminum alloy for electrical conductors.** Fiorini, P. (Ist Sper dei Met Leggeri, Italy). *Alluminio;* **44**: No. 5, 324-326(May 1975). (In Italian).

A description is given of a new low-alloyed aluminum-based material developed by Istituto Sperimentale dei Metalli Leggeri, combining high electrical conductivity (>61.5% of copper) with strength in excess of 13 kg/mm$sup 2$ and high resistance to repeated bending. Mechanical and electrical properties are given of the new alloy in different wire diameters and structural states. Tabular comparison between Almhoflex, E.C. grade Aluminum and copper is made. Almhoflex can be nickel plated by a proprietary ISML process to ensure perfect joints.

8284 **Method for calculating energy losses in operating distribution networks.** Anisimov, L.P.; Levin, M.S.; Pekelis, V.G. *Elektrichestvo;* No. 4, 27-30(Apr 1975). (In Russian).

The advantage of the method proposed lies in using more reliable initial information for operating conditions with allowance for the probability character of the information.

8285 **Convergence of iterative solution of steady-state equations of an electric power system with node capacities represented by constant impedances.** Smirnov, K.A. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 3-15(Mar-Apr 1975). (In Russian).

In considering the title problem, real and imaginary components of the voltages of the nodal points of the network are used as independent variables. Equations are investigated in a complex form. It is shown that when certain iteration equations are used in calculations the process of solution converges in the entire range of the operating regimes of the system, from the normal to the limiting conditions with respect to stability.

8286 **Use of the continuity principle in calculations of steady-state conditions of electric systems.** Bartolomei, P.I.; Erokhin, P.M. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 16-23(Mar-Apr 1975). (In Russian).

Use of the continuity principle to construct a variety of steady-state conditions, corresponding to changes in controlled parameters according to a set law, is considered. Also, its use in determining conditions of electric systems close to the limiting ones is dealt with. Solution of nonlinear equations of steady-state conditions is reduced to the integration of differential equations describing the motion along a weighting trajectory. Methods for constructing systems of differential equations and results of checking calculations are presented.

8287 **Optimization of the reliability of electric power supply in unified electric power systems at the long-term project design stage.** Shevchenko, A.T.; Sveshnikov, V.I. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 24-29(Mar-Apr 1975). (In Russian).

Problems of optimization of the reliability of electric power supply at the different levels of planning of unified electric power systems are considered. Criterial relations are presented, expressed with rated reliability index, for the determination of the requirements regarding the transmissive capacity of inter-system connections and the capacity reserves in power nodes constituting the unified system. It is shown that, in determining the reserves of static stability of inter-system connections, all the connections of the unified system in the initial regime must be loaded with capacity flows equal in value to their full transmissive capacity.

8288 **Use of the identification theory methods for the classification of breakdown conditions in an electric power system.** Bogatyrev, L.L.; Bogdanova, L.F. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 30-36(Mar-Apr 1975). (In Russian).

Construction of a decision rule is considered, on the basis of which identification of steady-state and unsteady conditions of an electric power system can be implemented. The hypersurface dividing the classes is constructed in the space of the main components, the dimensions of which are smaller than the dimension of the space of the initial system parameters characterizing its conditions. To increase the probability of correct classification of system conditions (from the point of view of stability of its operation) and to simplify the decision rule, the mapping of the space obtained on another space with better dividing properties is used.

8289 **Determination of power losses in the supply networks of electric power systems controlled by an automatic control system.** Pospelov, G.E.; Gurskii, S.K.; Pekelis, V.G.; Shimanskaya, T.A.; Anisimov, L.P. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 37-42(Mar-Apr 1975). (In Russian).

A probabilistic-statistical method of determination of energy losses in the main networks of electric power systems is proposed. The method is based on statistical convolution of information about past conditions of operation of the nodes of the main network to determine the mathematical expectation of power losses in the network during the respective period of time. The principal features of the method from the point of view of its application in conditions of automatic control systems are: adaptation of the tastes of retrospective analysis of operating conditions to the actually existing level of available information and the possibility of utilizing the values of power losses in the main networks for reliable planning.

8290 **Determination of reliability indices of elements of electric power systems.** Tsvetkov, V.A. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 140-145(Mar-Apr 1975). (In Russian).

Reliability of the operation and the probability of failure of a number of installations of an electric power system is determined by the values of some parameters of their operating conditions: vibrations, temperatures, etc. The problem of selection of the normative values for the permissible limit state parameters are posed and solved by way of minimization of conditional damage. Failure probability characteristics and functions of distribution of state parameters are used in solving the problem. Application of the method thus worked out is illustrated by an example of calculation of the maximum permissible vibration of hydrogenerator cores of polar frequency.

8291 **Calculation of power losses in electric networks by the method of experiment design.** Geraskin, O.T. *Izv. Akad. Nauk SSSR, Energ. Transp.;* No. 2, 145-151(Mar-Apr 1975). (In Russian).

Application of the theory of the design of experiments to the resolution of a basic problem of electric power engineering--calculation of active capacity losses in electric networks--is considered. Construction of the design matrix and implementation of a complete factorial experiment of the 2$sup n$ type is described. Also, realization of an experiment for the calculation of capacity losses in an electric network with the aid of a computer, normalization of the design matrix, computation of the coefficients of the model, and verification of the adequacy of the model obtained is described. The method of calculation is illustrated by a numeric example.

8292 Errors in determining energy losses in electric networks. Zhelezko, Y.S. (All-Union Sci Res Inst of Electr Power Eng, USSR). *Elektrichestvo;* No. 2, 19-22(Feb 1975). (In Russian).

The accuracy in determining energy loss in networks when using certain methods of calculations is analyzed. The problem is solved by a special program on digital computer. A method to significantly increase the accuracy is proposed. 4 refs.

8293 Causes for switching-off 110-220 kv overhead lines. Bussel', A.G.; Zhirnikov, G.A.; Obukhova, E.P.; Shargorodskii, V.L. *Elektrichestvo;* No. 2, 72-78(Feb 1975). (In Russian).

Results of analyzing the automatic cut-offs of 110-220 kv overhead lines in the Uzbek power system are presented.

8294 Polyfactorial correlation model for analyzing and predicting energy losses in transmission networks. Vorotnitskii, V.E. (B SSR Polytech Inst). *Elektrichestvo;* No. 1, 29-31(Jan 1975). (In Russian).

To solve the problem of analyzing, planning and taking measures against energy losses in electric power transmission networks the application of polyfactorial correlation models reflecting the statistical nature of energy losses and above all the important parameters of the networks is proposed. This approach significantly reduces the computer time for calculating and the work input for collecting and processing information. 4 refs.

8295 Analytical description of power and energy losses by econo-mathematical models of electric transmission lines. Berezhnoi, A.V. (B SSR Polytech Inst). *Elektrichestvo;* No. 1, 74-77(Jan 1975). (In Russian).

7 refs.

8296 Estimation, detection and identification methods in power system studies. Mishra, R.N. (GB Pant Univ of Agric and Technol, Pantnagar, India). *J. Inst. Eng. (India), Electr. Eng. Div.;* **55**: 207-211(1975).

The criterion chosen for the design of state estimator is a quadratic cost function of the state. The physical model is the same as for load flow, that is, the power equations, Ohm's law and Kirchoff's laws. A critical review of some of the developments in this area are presented and it is concluded that application of estimation, detection and identification methods to power system analysis is a solution.

8297 Evaluation of temporarily coupled stabilization elements during energy transfer. Nelles, D. (AEG-Telefunken, Frankfurt, Ger). *Bull. Schweiz. Elektrotech. Ver.;* **66**: No. 12, 625-631(1975). (In German).

Based on the equation of motion of the synchronous machine, the differential equations of state are presented for a system "generator-cable-network". From this, a limit of stability is derived, and the duration of short circuit was determined which is important as a measure of margin of safety for the stability of the system. A controller for the determination of switching conditions of the stabilization element is analyzed by an illustrative example.

AC SYSTEMS, EHV AND UHV

8298 Siemens BK circuit-breakers with improved performance. Bitsch, R.; Richter, F.; Schramm, H.H. (Siemens, Berlin, Ger). *Siemens-Z.;* **49**: No. 9, 600-605(Sep 1975). (In German).

A few years ago Siemens introduced their new range of SF_6-insulated high-voltage BK circuit-breakers. These breakers have been developed further and now have a higher making and breaking capacity and require less maintenance. The article gives an idea of the present state of the art as regards BK breakers for rated voltages between 245 and 525 kV. 9 refs.

8299 Transmission advantages for high voltages by high intensity cables. Rasquin, W. (Felten and Guilleaume Carlswerk, Cologne, Ger). *Elektrotech. Z., A;* **96**: No. 7, 284-289(Jul 1975). (In German).

Without overheating, high current can be transmitted in cables, provided they are forced cooled. Therefore, it follows that high power transmission may be possible solely by increasing the current of cables at low voltages. If such cables have to cover longer distances there would exist non-permissible differences between the magnitude of the voltage at the beginning and the end of the cable. In addition, the phase angle of the voltage at the beginning of the cable would be shifted too much in relation to that of the voltage at the end of the cable. This means that greater distances can only be covered by highpower cables, if not only high currents but also very high voltages are chosen.

8300 500kV aluminum sheathed oil-filled cable for Sodegaura power station of Tokyo Electric Power Co., Inc. Sato, N.; Miyahara, A.; Hikino, K.; Urabe, Y. (Tokyo Electr Power Co, Sodegaura Therm Power Stn, Jpn). *Hitachi Hyoron;* **24**: No. 6, 277-283(Jun 1975).

The specifications, construction, and installation of a 500 kv 1*1,200 mm$sup 2$ corrugated aluminum sheathed oil-filled cable are described. The cable has an insulation thickness of 33 mm and an outside diameter of 149 mm. The designs of a 6.5 m indoor pothead and an oil-immersed pothead are reviewed.

8301 Electric power supply of the new town of Evry. Bouvier, H.M.; Lagier, J. (Electr de Fr). *Rev. Gen. Electr.;* **84**: No. 6, 433-436(Jun 1975). (In French).

This paper describes the principles which prevailed during the design and development of the MV systems in double bypass of the new town of Evry. The authors give some particulars on the development techniques used and the materials selected for this system.

8302 Installation of the vhv supply system for energy transmission and environment. Pruvost, P. (Secr d'Etat a l'Environ, Fr). *Rev. Gen. Electr.;* **84**: No. 6, 441-443(Jun 1975). (In French).

The extension of line works: roads, railroads, HV transmission lines and various pipelines increasingly raises the problem of a coordinated location study. These considerations have led the author to apply himself to the problems arising in connection with the environment and which result from quantifiable and non-quantifiable effects upon human life.

8303 Power transmission system and the environment. Chaumont, P. (Electr de Fr). *Rev. Gen. Electr.;* **84**: No. 6, 444-447(Jun 1975). (In French).

Taking the forecast of requirements and the future prospects of the evolution of electric power consumption in France toward the 2000's, the main aspects of the power transmission system, now and in the future, as well as the psychological impact of the latter upon the public are considered. It is concluded that the necessary protection of the environment must not cause one to lose sight of the need to improve the quality of life which is a result of industrial development.

8304 Overhead lines and environment. Quey, F.J. (CERT, Fr). *Rev. Gen. Electr.;* **84**: No. 6, 448-453(Jun 1975). (In French).

The three fields in which problems of the aesthetics of overhead lines arise, i.e.: the tower itself, the open line, considered separately and finally the series of tower-borne lines as encountered in the vicinity of a substation are discussed. From each of these considerations are drawn concrete conclusions tending toward the search for better integration of these lines into the landscape and, at the same time, towards the definition of a reasonable overcost allowing the preservation of one of the aspects of the quality of life.

8305 Underground lines and environment. Ridon, R. (Electr de Fr). *Rev. Gen. Electr.;* **84**: No. 6, 457-458(Jun 1975). (In French).

The characteristics of HV cables as well as the voltage and power level which constitute the limit of their possibilities are considered. The cost price of an overhead line and of an underground line are compared and the constraints connected with the laying of the latter are investigated. It is concluded that presently the laying of underground lines is severely limited by technical and economic considerations. Later on these costs may be appreciably reduced.

8306 Improved cast-resin-insulated switchgear for bils of up to 120 kv with partially insulated truck-mounted circuit-breakers of new design. Luellwitz, G.; Stecker, W. (Siemens, Erlangen, Ger). *Siemens-Z.;* **49**: No. 4, 243-246(Apr 1975). (In German).

The time-tested switchgear of truck-type, cast-resin-insulated design has been developed further to include partially insulated T breakers and works assembled switchgear units. The new design permits the construction of single-level or two-level switchgear installations with due allowance for the outgoing feeder ratings. All the known circuit arrangements for switchgear with single and duplicate busbars are possible.

8307 8TJ2 switchgear interlock unit of modular design. Bonin, G.; Tischer, E. (Siemens, Berlin, Ger). *Siemens-Z.;* **49**: No. 4, 250-253(Apr 1975). (In German).

The 8TJ2 unit is designed for the control and interlocking of switchgear for 6 to 765 kV. The circuit-breakers may have any type of power-operated mechanism, whereas the disconnectors must be fitted with an electrical-type mechanism. The interlock unit is made up of plug-in control modules, which are interconnected by a works assembled and tested cable harness (also of plug-in design) to serve one feeder. The three basic types of control module can be combined to form switchgear interlock assemblies to suit any type of feeder arrangement. The advantage of having a ready assembled and test unit is fully retained by using the cable harness.

8308 Shunt compensation of series-compensated ehv long lines. Seth, S.P.; Gupta, S.R. (Reg Eng Coll, Kurukshetra, India). *J. Inst. Eng. (India), Electr. Eng. Div.;* **55**: 139-144(3 Feb 1975).

EHV long lines are invariably series-compensated. Capacitive generation poses a big problem on such lines during line charging and operation at low loads by causing an undesirable voltage rise along the line. Shunt reactors with their compensating effect on the

capacitive generation of the line offer an economical and technically sound means of confining these undesirable overvoltages within limits. Analytical expressions for optimum location and ratings of shunt reactors have been obtained in terms of series capacitor bank rating and location, line parameters and line length. The results were verified in laboratory on fabricated models of long transmission line, reactors and small power capacitors.

8309 Motor drive of the MTFG type for open-air hv circuit breakers. Jung, V. *Elin-Z.;* **27**: No. 1-2, 75-77(1975). (In German).

A motor drive with good operating capacity for the operation of outdoor hv-isolators has been developed by using a drive gear, which has been field-proved for decades, in combination with an up-to-date structure and control system. The maintenance-free unit offers universal adaptability and reliability thus giving it a wide field of application.

8310 Experimental investigations of physical processes occurring in high-voltage transmission circuit-breakers. Hertz, W.; Stroh, J.; Mentel, J.; Tiemann, W. (Siemens, Erlangen, Ger). *Siemens Forsch.- Entwicklungsber.;* **4**: No. 5, 281-288(1975).

The duties and the basic mode of operation of high-voltage circuit-breakers are briefly explained: Typical experiments are presented, the aims being to contribute to elucidating the physical phenomena of arc quenching; the final object is to improve the short-circuit breaking ability of a quenching system. In particular the following are dealt with: Breaking tests on a puffer test circuit-breaker, the behavior of arcs in a blast of SF_6 flowing through a double nozzle, the field strength distribution in such arcs, the phenomena in the arc roots, and finally the gas flow conditions in a double-nozzle system.

DC SYSTEMS

8311 Certain aspects of generation and control of abnormal harmonics in ehv dc transmission system. Goel, R.C. (Madan Mohan Malaviya Eng Coll, Gorakhpur, India). *J. Inst. Eng. (India), Electr. Eng. Div.;* **56**: 9-12(1 Aug 1975).

Various causes of generation of disturbing harmonics in EHVDC transmission system are discussed. Various factors affecting the magnitude of harmonics in synchronous alternators feeding the associated ac system are considered so that the level of the third, fifth and seventh harmonics in the output wave may be as small as possible. Some salient features of the mode of control for minimizing the harmonics and use of additional filters when harmonic resonance conditions are anticipated, are also discussed. Data are presented in tabular and graphical form.

8312 Adjustable inductors for the filter circuits of the high-voltage direct-current transmission line from cabora bassa to johannesburg. Dimmler, W.; Haubold, H.; Schraudolph, M.; Weigel, G. *AEG-Telefunken Prog.;* No. 1, 10-17(1975).

The article gives the specifications for the filter circuits and describes the design of the inductors. The static converters of the 1380 km HVDCT line from the hydro-electric power station at Cabora Bassa in Mozambique to the Apollo station near Johannesburg in the Republic of South Africa with a transmitted power of 1920 MW at $^{+}$-533 kV will be equipped, at full complement, with two identical filter circuit systems in both the rectifier and inverter stations. Apart from the different three-phase connection voltages--220 kV at Cabora Bassa and 300 kV at Apollo--the requirements for the various filter circuit systems are approximately the same for the rectifier and inverter stations. A separate series resonant circuit is provided for each typical harmonic. Such a circuit consists of a capacitor made up of a large number of modular capacitors in racks on potential tables, and of an inductor. A tunable design was chosen for the inductors. A bank winding consisting of twelve identical banks is arranged at the star-point end of each inductor winding and allows the setting of altogether 25 different single-sense inductances.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

8313 (NP—22472) **Investigations on breakdown events in liquid nitrogen at high voltages.** Peier, D. (Technische Univ. Braunschweig (Germany, F.R.). Fakultaet fuer Maschinenbau und Elektrotechnik). 25 Jun 1975. 134p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Thesis.

The breakdown of liquid nitrogen was investigated using dc, ac and impulse voltages up to 200 kV. The electrode arrangement varied from point-to-plane electrodes with point radii of 40 μm to electrodes with nearly homogeneous fields. Electrode material and surface roughness were taken into account. The prebreakdown events were studied by the charge of the electrode, the breakdown itself by measuring the voltage and the current. Some types of instable predischarges were detected, but no stable ones. The immediately following breakdown occurred within 20 ns. The breakdown field strength depends on the gap distance s and the electrode radius r. There is a minimum field strength due to the ratio of $s/r = 5$ to 20. At a gap distance of 1 mm breakdown voltages of 50 kV were measured at ac and dc under atmospheric pressure (homogeneous field). This value is influenced by the surface roughness and the heat flux into LN_2. Electrode material is only of little influence. Based on these measurements some aspects of a breakdown mechanism are pointed out: electrons, generated by field emission, may cause microbubbling in front of microtips on the surface. The microbubbles may be the starting point for ionization processes and avalanches, leading to a breakdown channel. The channel build up is similar to the streamer and leader mechanism, observed in long air gaps.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 8613

8314 (BNWL—2256) **Behavior of spent nuclear fuel in water pool storage.** Johnson, A.B. Jr. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-06-1830. 104p. Dep. NTIS, PC A06/MF A01.

Storage of irradiated nuclear fuel in water pools (basins) has been standard practice since nuclear reactors first began operation approximately 34 years ago. Pool storage is the starting point for all other fuel storage candidate processes and is a candidate for extended interim fuel storage until policy questions regarding reprocessing and ultimate disposal have been resolved. This report assesses the current performance of nuclear fuel in pool storage, the range of storage conditions, and the prospects for extending residence times. The assessment is based on visits to five U.S. and Canadian fuel storage sites, representing nine storage pools, and on discussions with operators of an additional 21 storage pools. Spent fuel storage experience from British pools at Winfrith and Windscale and from a German pool at Karlsruhe (WAK) also is summarized.

8315 (ERDA—77-30/3) **U.S. central station nuclear electric generating units: significant milestones.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Nuclear Research and Applications). 1 Jul 1977. 15p. Dep. NTIS, PC A02/MF A01.

8316 (GIBSAR—17-A(Amend.3)) **Quality assurance program.** (Gibbs and Hill, Inc., New York (USA)). Jul 1977. 100p. and Hill, Inc., New York, NY.

This topical report describes the Gibbs and Hill Quality Assurance Program and sets forth the methods to be followed in controlling quality-related activities performed by Gibbs and Hill and its contractors. The program is based on company experience in nuclear power and related work, and defines a system found effective in providing independent control of quality-related functions and documentation. The scope of the report covers activities involving nuclear safety-related structures, systems, and components covered by Gibbs and Hill' contractual obligation to the Utility Owner for each project.

8317 Finland's energy policy. Berner, A. *Ingenioer-nytt;* **13**: No. 39, 29-30(16 May 1977). (In Norwegian).

From Nordic Energy Conference; Stavanger, Norway (26 - 27 Apr 1977).

In describing Finland's energy political situation, it is pointed out that the climate makes necessary the use of large amounts of energy for heating and Finland's geography also requires the use of large amounts in the communication system. Finnish industry, based on the exploitation and refinement of the natural resources of wood and minerals, also consumes large amounts of energy. Hydroelectric resources, which supplied half the energy esed in the early 1960s, are virtually totally exploited. Oil is imported from the USSR and coal from USSR and Poland on long-term contracts. Nuclear power plants have been purchased from the USSR (the Loviisa 1 and 2 plants) and from Sweden (TVO 1 and 2). The uranium for the latter plants is purchased from Canada and will be enriched in the USSR, while the fuel element manufacture will take place in Sweden. Negotiations with the USSR for the purchase of a 1000 MW nuclear power plant are under way. If future power production is also based on nuclear power, then 30 % of the power in year 2000 will be nuclear.

8318 Nuclear power. Lubbers, R.F.M. (Ministerie van Economische Zaken, The Hague (Netherlands)). *Econ. Stat. Ber.;* **62**: No. 3102, 404-409(4 May 1977). (In Dutch).

The author is the Minister of Economic Affairs. He has written this article to give an answer to the abundant discussions on the nuclear power controversy by motivating the designed government plans for the provision of electricity. He deals with the following aspects: safety, future demand, military dangers, international cooperation and control, and more specifically with President Carter's line of thought and its consequences for the rest of the

world. The energy problem needs to be tackled with the greatest possible care where nuclear energy is concerned, and the Netherlands should play a positive role in international cooperation.

8319 Role of nuclear power in meeting future energy demands. Fuchs, K. (Akademie der Wissenschaften der DDR, Dresden. Forschungsbereich Physik, Kern- und Werkstoffwissenschaften); Schumann, G. (Ingenieurhochschule Zittau (German Democratic Republic)). *Energietechnik;* **27**: No. 5, 185-192(May 1977). (In German).

From 4. power economy conference; Zittau, German Democratic Republic (17 Nov 1976).

Future energy demands and possibilities of meeting them are outlined. The current status and future developments of nuclear energetics all over the world and in the CMEA member states are discussed considering reactor safety, fission product releases, and thermal pollution of the environment.

8320 Evolution and development of nuclear energy. Gihel, F. *Rev. Energ.;* **27**: No. 287, 469-473(Oct 1976). (In French).

The evolution of nuclear energy and programs in Western European countries is briefly reviewed.

8321 Swedish nuclear power. Hermansky, B. *Jad. Energ.;* **22**: No. 9, 343-349(Sep 1976). (In Czech).

A brief review is given of the power situation in Sweden and of the development programme of nuclear power production in that country, including the construction and operation of light water reactors Oskarshamn 1,2, Ringhals 1,2,3,4 and Barsebaeck 1,2. The further research and development in nuclear power production in Sweden is discussed, namely financing, the safety of nuclear installations, radioactive waste disposal, nuclear heat and power plants, prospective types of reactors, uranium mining and processing. The development and current position of the anti-nuclear lobby in Sweden is dealt with in detail.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 8417, 8480, 8482, 8484, 8487, 8498, 8500, 8507, 8508, 8523, 8527, 8528, 8529, 8530, 8533, 8534

8322 (CONF-770902—1) **Characterization studies of BWR-4 neutron noise analysis spectra.** Mathis, M.V.; Smith, C.M.; Fry, D.N.; Dailey, M.L. (Technology for Energy Corp., Knoxville, Tenn. (USA); Oak Ridge National Lab., Tenn. (USA); Tennessee Valley Authority, Chattanooga (USA)). 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From Specialists meeting on reactor noise; Gatlinburg, Tennessee, United States of America (USA) (19 Sep 1977).

Neutron noise analysis measurements were made in three BWR-4 reactors under full-power conditions to determine the noise characterization spectra of the reactors with two different instrument-tube cooling configurations. Both configurations were designed to prevent flow-induced vibration of the instrument tubes and subsequent damage of fuel channel boxes caused by impacts of the tubes with the boxes. Noise spectra from these three reactors were compared with spectra previously obtained prior to changing the instrument-tube cooling configuration, and no evidence of impacting was found.

8323 (CONF-770902—4) **Identification of neutron noise sources in a boiling water reactor.** Sides, W.H. Jr.; Mathis, M.V.; Smith, C.M. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

From Specialists meeting on reactor noise; Gatlinburg, Tennessee, United States of America (USA) (19 Sep 1977).

Measurements were made at units 2 and 3 of the Browns Ferry Nuclear Power Plant in order to characterize the noise signatures of the neutron and process signals and to determine the usefulness of such signatures for anomaly detection in BWR-4s. Previous measurements and theoretical analyses of BWR noise by others were concerned with the determination of steam velocity and void fraction (using the local component of neutron noise) and with the sources of global noise. The work described is under a five-part program to develop a complete and systematic analysis and representation of BWR neutron and process noise through complementary measurements and stochastic model developments. The parts are: (1) recording as many neutron detector and process noise signals as are available in a BWR-4; (2) reducing these data to noise signatures in order to perform an empirical analysis of these signatures, and documenting the relationships between the signals from spatially separated neutron detectors and between neutron and process variables; (3) developing spatially dependent neutronic models coupled with thermal-hydraulic models to aid in interpreting the observed relationships among the measured noise signatures, (4) comparing measured noise signatures with model predictions to obtain additional insight into BWR-4 dynamic behavior and to validate the models; and (5) using these models to predict the sensitivity of noise monitoring for detection, surveillance, and diagnosis of postulated in-core anomalies in BWRs. The paper describes the procedures used to obtain the noise recordings and presents initial empirical analysis and observations pertaining to the noise signatures and the relationships between several noise variables in the 0.01- to 1-Hz range. The mathematical models have not been developed sufficiently to report theoretical results or to compare measured spectra with model predictions at this time.

8324 (DPST-NUREG—77-1) **WRAP: a water reactor analysis package.** Anderson, M.M. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jun 1977. Contract EY-76-C-09-0001. 23p. Dep. NTIS, PC A02/MF A01.

The modular computational system known as the Water Reactor Analysis Package (WRAP) has been developed at the Savannah River Laboratory. WRAP is essentially a reprogrammed version of the RELAP4 computer code with an extensively restructured input format, a dynamic dimensioning capability and additional computational capabilities such as an automatic steady-state option for pressurized water reactors and an automatic restart capability with provision for renodalization. The report describes the capabilities of WRAP at its current stage of development. The addition of new capabilities (e.g., a BWR steady-state capability), the inclusion of improved models (e.g., models in RELAP4/M0D8) and the development of improved numerical techniques to reduce execution time are being planned at this time.

8325 (EPRI-NP—472) **Reactor core physics design and operating data for cycles 1, 2, and 3 of the Monticello BWR Nuclear Generating Plant. Final report.** (Nuclear Associates International Corp., Rockville, Md. (USA)). Jul 1977. 500p. Dep. NTIS, PC A21/MF A01.

Procedures were written and used for the collection of design and operating data from a boiling water reactor (BWR). The design and operating data were assembled carefully in tabular form and have been verified by experienced nuclear engineers of both NSP and NAI. Data sources are identified on the forms to permit a quality audit. The resulting tables provide a source of reactor data for input to the ARMP code package which has not been available previously in a single document. A link is provided between these data and input to the EPRI-CELL, EPRI-NODE, and EPRI-THERM codes by reference to the appropriate tables and data items. Notations helpful for input preparation are included.

8326 (IAE—2575) **Measurement of local steam content by electric probe.** Vladimirtsev, S.I.; Karmanov, F.V.; Smolyar, A.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 24p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A method was described for measuring the local vapour content in two-phase flows with an electric probe. To verify the reliability of the measurements, a concurrent photographic recording of the two-phase flow was carried out in the area occupied by the probe. The experiments were performed on a water-air mock-up of a power reactor channel cell. The probe, functioning according to the principle of electrical resistance, could be moved along to study the phase distribution in the channel section. The main measuring element of the circuit is a long line with distributed parameters (a coaxial cable some 50 m long) and a wave resistance of 75 ohm. The resonance resistance was achieved at characteristic frequences over the range of about 20 to 35 Mcps. A change in the conductivity of the two-phase medium at the point where the detector is placed as a result of a phase shift, leads to the carrier frequency modulating by amplitude. Separation of the effective signal from the high frequency oscillation of the circuit is accomplished with a conventional diode detector. Processing of the photographic records of the flow patterns was reduced to calculation of the mean radii of despersoids from the two axes. Processing of the tracing tapes consisted in measuring the half-widths of the pulse and obtaining frequency patterns of the electric-probe signal recorded. The noise level was about 6% of the maximum height of the amplitude. The figures show phase distributions in the channel section for some flow patterns, recording of the signal from the electric probe to locate its positions in the channel, as well as the relationship between the electric signal and the size of the bubble.

8327 (NEDC—21581) **In-plant safety/relief valve discharge load test, Monticello Plant. Final report.** Buzek, E.A. (comp.). (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Aug 1977. vp. Electric Co., San Jose, CA.

This document reports the results of the test program of safety/relief valve (SRV) discharge load phenomena through a ramshead discharge device, and the effects upon the Mark I primary containment torus structure of the Monticello Nuclear Power Plant. The objectives were to provide a data base for verifying/improving bubble pressure, water reflood and piping load analytical models,

and to measure the structural response of the torus, SRV piping, supports and acceleration of the basement and pedestal.

8328 (NRL/NUREG/MR—3600) **Structural integrity of water reactor pressure boundary components. Progress report ending 31 May 1977.** Loss, F.J. (ed.). (Naval Research Lab., Washington, D.C. (USA)). Sep 1977. 49p. NTIS.

This report describes research progress in a continuing program to characterize materials properties performance with respect to structural integrity of light water reactor pressure boundary components. Progress for this reporting period is summarized in the following areas: (a) evaluation of critical factors in fatigue crack growth rate studies in a pressurized water reactor environment; (b) fractographic observations of fatigue crack propagation; (c) the IARAR program and its objectives; (d) the effect of submerged arc welding on the notch toughness of low upper shelf A302-B plate exhibiting a low upper shelf and its weld HAZ, and (e) surveys of foreign research related to the safety of light water reactors in Japan, United Kingdom, France, and Germany.

8329 (UCID—17594) **Dynamic response analysis of the PSE torus.** Arthur, D.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Sep 1977. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

The paper describes a structural dynamic analysis of the 1/5-scale BWR toroidal wetwell. The subscale toroidal wetwell is part of the Pressure Suppression Experiment Facility at Lawrence Livermore Laboratory. The analysis objective is to show that experimental structural loads measured by load cells in the wetwell supports are consistent with the internal hydrodynamic forcing function measured by pressure transducers. Finite element analysis of the wetwell indicates that the load and pressure measurements are consistent.

8330 **Reactor fuel reliability constraints on power shape control.** Gelhaus, F. (Electric Power Research Inst., Palo Alto, CA); Hallam, J.; Sauar, T. *Nucl. Sci. Eng.:* **64**: No. 2, 684-693(Oct 1977).

The level of reliability of fuel rods operating in commercial nuclear power plants has been less than desired for a number of reasons. Several of these causes have been successfully minimized, but pellet-clad interaction failures persist. Since power and power change are dominant parameters in this failure mode, restrictions on operational maneuvers have been recommended by all U. S. fuel suppliers. Slower-than-design allowable maneuvers decrease the plant capacity factor, which can cost a utility up to $7 million per year per plant. To assist utility engineering and operations personnel in their day-to-day decisions in this regard, the Electric Power Research Institute (EPRI) is initiating a project, designated RP895, to develop a fully computerized Power Shape Monitoring System (PSMS) for core-wide fuel rod reliability prediction. This paper describes the PSMS system and details some of the hardware/software requirements as they are now perceived. Salient results from a just-completed complementary EPRI-funded study, RP509, are described; this effort employed hand data acquisition and many man-machine interfaces that will be fully integrated and automated in the PSMS. The capabilities of the PSMS will derive from the use of modern minicomputer hardware and software and from accurate computational modules that enable near-real-time predictive capability.

8331 **Optimal pin enrichment distributions in boiling water reactor fuel bundles.** Lim, E.Y.; Leonard, A. (Stanford Univ., CA). *Nucl. Sci. Eng.:* **64**: No. 2, 694-708(Oct 1977).

A methodology is developed to determine the fuel pin enrichment distribution that yields the best approximation to a prescribed power distribution in boiling water reactor fuel bundles. Optimal pin enrichments are defined as those that minimize the sum of squared deviations between the actual and prescribed fuel pin powers. A constant average enrichment constraint is imposed to ensure that a suitable value of reactivity is present in the bundle. In the special case when each pin in the bundle is permitted to have a different enrichment value, the solution is obtained iteratively using a projected gradient algorithm. Gradient information and power distributions are computed by adapting the response matrix method to fuel bundle power calculations. In the general case when the fuel pins are limited to a few enrichment types, one obtains a combinatorial optimization problem. Formally, the assignment of an enrichment type to the various fuel pins is made through a matrix of Boolean variables. Since the optimal assignment, as well as the optimal values, of the enrichment types must be determined, a nonlinear mixed integer programming problem must be solved. Algorithms based on either exhaustive enumeration or branch and bound are shown to give a rigorous solution, but are computationally overwhelming. Solutions that require only moderate computational effort are obtained by assuming that the fuel pinenrichments in the combinatorial problem maintain the ordering that was found in the special case mentioned above. Search schemes using branch and bound now become computationally attractive. An adaptation of the Hooke-Jeeves pattern search technique is shown to be especially efficient.

8332 **CEGB statistical yearbook 1976—77.** *CEGB Res.;* 1-20(1977).

Tabulated data prepared by the Central Electricity Generating Board in the U.K. (CEGB) of statistics on electric power generation, transmission, consumption, and costs, on fossil-fuel and nuclear power plant equipment, construction, operation and fuel costs, and financial statistics for 1976-77 are presented. (LCL)

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 8277, 8324, 8328, 8330, 8417, 8449, 8480, 8482, 8484, 8487, 8496, 8497, 8498, 8505, 8523, 8526, 8531, 8532, 8533, 8534, 8535

8333 (BAW—10039(Suppl.1)) **Prototype vibration measurement results for B and W's 177-fuel assembly, two-loop plant.** Thoren, D.E.; Simonis, J.C.; Vames, G.J.; Harris, R.J. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Aug 1977. 52p. and Wilcox Co., Lynchburg, VA.

The report describes the vibration assessment program (VAP) for the newly designed surveillance specimen holder tube assembly. Described is the measurement program or VAP conducted at Davis-Besse Unit 1, the predicted responses, and the results of the interpretations from the measurements that verify structural integrity. The program qualifies the design for use on the Davis-Besse 1 internals and other B and W 177-FA reactor internals.

8334 (BAW—10096A(Rev.3)) **B and W NPGD quality assurance program for nuclear equipment. Revision 3.** (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Apr 1977. vp. and Wilcox Co., Lynchburg, VA.

The Babcock and Wilcox quality assurance program for the design, procurement, and manufacturing of equipment for its nuclear steam supply system is presented.

8335 (CENPD—256) **Licensing submittal to the NRC for the irradiation of test fuel rods in a 16x16 nuclear reactor.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Aug 1977. 34p. Engineering, Inc., Windsor, CT.

A proposal for the irradiation testing of PWR 16 x 16 fuel assemblies is presented.

8336 (DPST-NUREG—77-3) **PR steady-state capability of WRAP-A water reactor analysis package.** Sharp, D.A. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jun 1977. Contract EY-76-C-09-0001. 20p. Dep. NTIS, PC A02/MF A01.

The report describes the computational procedure employed in the Water Reactor Analysis Package (WRAP) to determine the steady-state operating conditions of a pressurized water reactor (PWR). The WRAP modular computational system, developed at the Savannah River Laboratory, is a reprogrammed version of the RELAP4 computer code with an extensively restructured input format, a dynamic dimensioning capability, and additional computational capabilities such as this procedure. This procedure can be used to compute the equilibrium volume states, core flow rates, and pump and steam generator characteristics corresponding to a particular PWR system nodalization. With this procedure, PWR transients may be computed by the WRAP system without extensive manual calculations of the initial conditions.

8337 (EPRI-NP—160(Vol.2)) **1/3 scale air—water pump program, pump performance data. Volume II.** Winks, R.W. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Oct 1977. 442p. Dep. NTIS, PC A19/MF A01.

Steady-state pump performance was measured on a one-third-scale model reactor coolant pump in an air-water test loop where temperatures varied from 58 to 118°F, pressures ranged from 5 to 95 psig, water flow rates varied from 650 to 9000 gpm, and air flow rates ranged from 0 to 4000 scfm. Various air-water mixtures between 0 and 90% void fraction were supplied to the test pump for locked-rotor, free wheeling, and powered operation. The test data comprise 862 steady-state operating conditions with 522 test points recorded for pump operation in the first quadrant. Homologous pump performance data have been calculated with a digital computer code, WAPMP, which is listed ahead of the test data.

8338 (EPRI-NP—516) **PWR secondary water chemistry study.** Pearl, W.L.; Sawochka, S.G. (Nuclear Water and Waste Technology, San Jose, Calif. (USA)). Feb 1977. 173p. Dep. NTIS, PC A08/MF A01.

Several types of corrosion damage are currently chronic problems in PWR recirculating steam generators. One probable cause of damage is a local high concentration of an aggressive chemical even though only trace levels are present in feedwater. A

wide variety of trace chemicals can find their way into feedwater, depending on the sources of condenser cooling water and the specific feedwater treatment. In February 1975, Nuclear Water and Waste Technology Corporation (NWT), was contracted to characterize secondary system water chemistry at five operating PWRs. Plants were selected to allow effects of cooling water chemistry and operating history on steam generator corrosion to be evaluated. Calvert Cliffs 1, Prairie Island 1 and 2, Surry 2, and Turkey Point 4 were monitored during the program. Results to date in the following areas are summarized: (1) plant chemistry variations during normal operation, transients, and shutdowns; (2) effects of condenser leakage on steam generator chemistry; (3) corrosion product transport during all phases of operation; (4) analytical prediction of chemistry in local areas from bulk water chemistry measurements; and (5) correlation of corrosion damage to chemistry variation.

8339 (IBK—1415) **Certification of materials for steam generator condensor and regeneration heat exchanger for nuclear plant.** Stevanovici, M.V.; Jovashevici, V.J.; Jovashevici, V.D.J.; Spasici, Z.L. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1977. 58p. (In Serbian). Dep. NTIS (US Sales Only), PC A04/MF A01.

In the construction of a nuclear power plant almost all known materials are used. The choice depends on working conditions. In this work standard specifications of contemporary materials that take part in larger quantities in the following components of the secondary circuit of PWR-type nuclear power plant are proposed: steam generator with moisture separator, condensor and regenerative heat eXchanger.

8340 **Normal operating radiation levels in pressurized water reactor plants.** Sejvar, J. (Westinghouse Electric Corp., Pittsburgh). *Nucl. Technol.;* **36**: No. 1, 48-55(Nov 1977).

Operating plant radiation level measurements are important in optimizing the operation of nuclear plant systems and in confirming methods and assumptions used by shield designers and must be evaluated to aid in improving future plant designs. In addition, the anticipated long-term radiation fields to which reactor components are subjected are an important consideration in materials selection and/or placement. Radiation level measurements obtained from various pressurized water reactor plants show a wide range of measured dose rates, both in certain areas of the plant (e.g., containment operating deck) and near various components. In some cases, the differences can be explained based on variations in plant layout and shielding configuration, extent of fuel cladding failures, etc., but in many cases, the reported values lack sufficient detail and appropriate explanatory information to correctly interpret the data. The measurements that have been accumulated and correlated thus far are being used to confirm the assumptions and models currently being employed by the shield designers and have led to system and equipment design improvements.

8341 **Possible mechanism for corrosion product transport and radiation field growth in a pressurized water reactor primary circuit.** Burrill, K.A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). *Nucl. Technol.;* **36**: No. 1, 85-92(Nov 1977).

Gamma radiation fields grow with time on the piping and other components in the primary circuit of all water-cooled nuclear reactors. Corrosion products that have been released from the out-reactor surfaces, made radioactive in the core, and then deposited on out-reactor surfaces cause the fields to grow. Corrosion product deposits on fuel sheaths exposed to nonboiling water in an in-reactor loop test are used to show the importance of high-temperature pH in the process of corrosion product transport. A possible mechanism for radiation field growth in light water reactors is then deduced from this test.

8342 (NUREG-tr—0009) **Hydraulic studies of the lower plenum of a pressure water reactor vessel.** Weber, E.; Dittrich, W. (Siemens A.G., Erlangen (Germany, F.R.)). Oct 1977. Translation of BMFT-FB-K—73-03. 61p. Regulatory Commission, Washington, DC.

It was known that the shape of the lower plenum and the core catching structure influence the velocity distribution at the core entry. It was tried to equalize the velocity distribution by finding the optimum design for the core catching structure. The investigations were carried out with an air model of a 4-loop-reactor. First the flow pattern in the lower plenum was measured. Then the number and position of the plates of the core catching structure were varied. The distance between the bottom of the plenum and the lowest plate is of decisive importance. This distance must be smaller than the width of the jet produced by an annulus. Furthermore, the equalizing effect of a slight swirl or a cylindrical screen was shown.

8343 **Coated particle fuel element for pressurized water reactors.** Katscher, W. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 557-563(Sep 1977).

Direct cooling of coated particles by water is a possibility for significantly increasing the power density in the core of pressurized water reactors beyond that common at present. The problems of hydrodynamics, thermodynamics, and production technology involved have been examined and found to be tractable. By means of burnout experiments using induction heating, it has been demonstrated that it is possible to safely cool packed beds of small spheres directly by water, even at the low flow rates that must be specified to limit the pressure drop to values representative of present high-power-density cores. Electron beam drilling was shown to be an adequate method for producing the perforated support structure for the particle beds. Clarification of problems with respect to neutron physics, cost-effectiveness, or specific safety engineering will require further investigation.

8344 **Brazil throws down gauntlet to Carter as work starts on Angra 2 and 3.** Smith, D. *Nucl. Eng. Int.;* **22**: No. 257, 35-37(May 1977).

The political implications raised by the start of construction work on the Brazilian Angra-dos-Reis 2 and 3, the first of eight PWR units to be supplied by Germany, are considered in relation to future reprocessing requirements. Exploration and recovery of uranium resources, growth in energy demand, and siting problems, in Brazil, are discussed.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 8071, 8428, 8483, 8485, 8499, 8506, 8533, 8542

8345 (CEGB-RD/B/N—3943) **Monitoring engineering structures by the comparison of similar photographs.** Jones, A. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Dec 1976. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A commonly used method of monitoring engineering structures is to compare similar photographs taken at different times. The initial part of this note deals with commercially available equipment, known as a comparascope, which enables differences between photographs to be rapidly (and reliably) detected. A series of practical tests is described in which it is established that a change in dimensions of 0.05mm can be detected between photographs. For typical camera systems, this will usually correspond to detectable displacements of the order of several mm in object space. Perhaps the most serious disadvantages of the technique is that alterations in camera attitude between photographs can cause changes in the recorded image which mask genuine movements in the structure. The changes caused by a given shift in camera attitude are, therefore, investigated theoretically. Since it is desirable that the changes are small enough to go undetected in the comparison, the established detection limit of the comparascope is included in the investigation to specify how accurately the camera attitude must be controlled for a given set of experimental circumstances. As a result, it appears that a special purpose camera mounting will nearly always be required if structural differences as small as several mm are to be reliably detected. Hand-held cameras should only be used for relatively coarse monitoring tasks.

8346 (CONF-770929—6) **Fission product behavior in the Peach Bottom HTGR.** Malinauskas, A.P.; Dyer, F.F.; Fairchild, L.L.; Martin, W.J.; Wichner, R.P. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, New York, USA (15 Sep 1977).

The Peach Bottom high temperature, gas-cooled nuclear reactor, a 115-MW(t) power station, was placed in commercial operation on June 1, 1967. Operation with the initial core ended in October 1969 after 452 equivalent full power days (EFPD) had elapsed. Power production resumed on July 14, 1970 with the second core, and continued through October 31, 1974. During this period, Core 2 accumulated 897 EFPD operation. Fission product surveillance was intensified with the initiation of Core 2 operation. The Loop 1 coolant circuit was modified to accept probes for sampling the coolant at points upstream and downstream of the steam generator, and monitoring stations were established to measure gamma-emitting fission products which were deposited along the Loop 1 coolant circuit surfaces. The locations of the sampler probes and the gamma-ray monitoring stations are identified in the schematic representation of the reactor system in Fig. 1. The samplers operated continuously while the reactor was at power, and were replaced during reactor shutdowns. Shutdown periods likewise afforded opportunities for determinations of deposited activity at the gamma-ray monitoring stations and for the collection of dust samples from the cyclone separator in the loop. In addition, extensive postirradiation examinations were made of fuel elements which had been removed from the reactor at 385 EFPD, 701 EFPD, and end-of-life.

8347 (GA-A—14376) **Study of tritium permeation through Peach Bottom Steam Generator tubes.** Yang, L.; Baugh, W.A.; Baldwin, N.L. (General Atomic Co., San Diego, Calif. (USA)). Jun 1977. Contract EY-76-C-03-0167-056. 41p. Dep. NTIS, PC A04/MF A01.

The report describes the equipment developed, samples tested, procedures used, and results obtained in the tritium permeation tests conducted on steam generator tubing samples which were removed from the Peach Bottom Unit No. 1 reactor.

8348 (GA-A—14544) **Gas turbine HTGR program. Quarterly progress report for the period ending June 30, 1977.** (General Atomic Co., San Diego, Calif. (USA)). Jul 1977. Contract EY-76-C-03-0167-046. 38p. Dep. NTIS, PC A03/MF A01.

This report reviews the two General Atomic Company (GA) plant conceptual designs [a 3-loop nonintercooled variant and a 2-loop intercooled plant, both based on a 3000 MW(t) reactor core] and a comparison is made with the single-loop plant studied by the HHT project.

8349 (HEDL-SA—1274) **Computerized x-ray radiographic system for fuel pellet measurements.** Green, D.R.; Karnesky, R.A.; Bromley, C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1977. Contract EY-76-C-14-2170. 46p. (CONF-771033—1; CONF-770941—1; CONF-770856—1). Dep. NTIS, PC A03/MF A01.

From ASNT conference; Detroit, Michigan, USA (1 Oct 1977).

The development and operation of a computerized system for determination of fuel pellet diameters from x-ray radiography is described. Actual fuel pellet diameter measurements made with the system are compared to micrometer measurements on the same pellets, and statistically evaluated. The advantages and limitations of the system are discussed, and recommendations are made for further development.

8350 (Juel—1383) **Comparison of control-rod-models in two- and three-dimensional geometry demonstrated at the example of the 300 MW(E)-THTR-nuclear power station Schmehausen.** Scherer, W.; Gerwin, H.; Vogel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Feb 1977. 61p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The evaluation of the efficiency of control rods in High Temperature Reactors is in general a 3-dimensional problem. Because of the big effort for 3-dimensional calculations it is very important to develop 2-D-models with sufficient accuracy. In this study a comparison of 2-D and 3-D neutron physical models was performed for the specific case of the THTR-300 and the approximations resulting from familiar 2-D-models were analysed. The results show that the 2-D-curtain-model gives a very good reactivity-estimation for the considered cases, whereas the rod-efficiency determined by the ring-model drops out about 10% too low. The flux curve near the rods is predicted inexactly by the regarded 2-D (R-Z)-models. For precise determination of the rod-near neutron distribution the bigger effort of 3-D-representations is justified.

8351 (LA-NUREG—6500) **QUIL: a chemical equilibrium code.** Lunsford, J.L. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1977. Contract W-7405-ENG-36. 80p. Dep. NTIS, PC A12/MF A01.

A chemical equilibrium code QUIL is described, along with two support codes FENG and SURF. QUIL is designed to allow calculations on a wide range of chemical environments, which may include surface phases. QUIL was written specifically to calculate distributions associated with complex equilibria involving fission products in the primary coolant loop of the high-temperature gas-cooled reactor. QUIL depends upon an energy-data library called ELIB. This library is maintained by FENG and SURF. FENG enters into the library all reactions having standard free energies of reaction that are independent of concentration. SURF enters all surface reactions into ELIB. All three codes are interactive codes written to be used from a remote terminal, with paging control provided. Plotted output is also available.

8352 (ORNL/TM—6001) **Creep-rupture properties and corrosion behavior of 2 1/4 Cr-1 Mo steel and Hastelloy X alloys in simulated HTGR environment-interim report.** Lystrup, A.S.; Rittenhouse, P.L.; DiStefano, J.R. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 42p. Dep. NTIS, PC A02/MF A01.

Hastelloy X and 2¼ Cr-1 Mo steel are being considered as structural alloys for components of a High-Temperature Gas-Cooled Reactor (HTGR) system. Among other mechanical properties, the creep behavior of these materials in HTGR primary coolant helium must be established to form part of the design criteria. This report describes the simulated HTGR-helium environmental creep facilities, summarizes preliminary creep properties of 2¼ Cr-1 Mo steel and Hastelloy X generated in HTGR helium and compares these with data obtained by testing in air. Some corrosion characteristics of the two materials are also discussed.

8353 **Coated particle fuels.** Gulden, T.D. (General Atomic Co., San Diego, CA); Nickel, H. *Nucl. Technol.;* **35**: No. 2, 206-213(Sep 1977).

The development of coated particle fuels for HTGR type reactors is reviewed. The reactor types and fuel element designs are described. Also discussed are coating materials, coated particle performance, fission product release, and advanced fuels.

8354 **Improved gas distributor for coating high-temperature gas-cooled reactor fuel particles.** Lackey, W.J.; Stinton, D.P.; Sease, J.D. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **35**: No. 2, 227-237(Sep 1977).

A new and improved gas distributor was developed for use in coating fuel particles for the high-temperature gas-cooled reactor. The coating gas enters the coating furnace through multiple thin regions of a porous plate. This more uniformly disperses the gas and leads to improved coating properties. High-quality carbon and silicon carbide coatings were deposited with the new distributor in both 13- and 24-cm (130- and 240-mm)-diam coating furnaces.

8355 **Coated fuel particles: requirements and status of fabrication technology.** Huschka, H.; Vygen, P. (Hochtemperaturreaktor-Brennelement GmbH, Hanau, Ger.). *Nucl. Technol.;* **35**: No. 2, 238-245(Sep 1977).

Fuel cycle, design, and irradiation performance requirements impose restraints on the fabrication processes. Both kernel and coating fabrication processes are flexible enough to adapt to the needs of the various existing and proposed high-temperature gas-cooled reactors. Extensive experience has demonstrated that fuel kernels with excellent sphericity and uniformity can be produced by wet chemical processes. Similarly experience has shown that the various multilayer coatings can be produced to fully meet design and specification requirements. Quality reliability of coated fuel particles is ensured by quality control and quality assurance programs operated by an aduiting system that includes licensing officials and the customer.

8356 **Nuclear fuel coated particle development in the reactor fuel element laboratories of the U.K. Atomic Energy Authority.** Allen, P.L.; Ford, L.H.; Shennan, J.V. (United Kingdom Atomic Energy Authority, Springfields, Eng.). *Nucl. Technol.;* **35**: No. 2, 246-253(Sep 1977).

The objectives of the coated particle development program at the Reactor Fuel Element Laboratories (RFL) have been to define the essentials of a production route for the manufacture of nuclear fuel kernels and coated particles and to identify the important process parameters that determine the particle properties and hence the irradiation performance. Detailed characterization assessments of the various components of the coated particles have enabled a number of advanced coated particle designs to be optimized. The versatility of the RFL powder agglomeration process for the fabrication of highly spherical carbide or oxide kernels is exemplified by its ability to produce virtually monosized kernels in the range from 200 to 1000 μm in diameter, with controlled porosities in the range from 5 to 20 percent and the facility with which solid fission product and oxygen getters may be incorporated. The principles of the RFL pyrocarbon (PyC) and silicon carbide (SiC) coating processes, together with the experience of coating particles on a large--kernel batch sizes up to 25 kg--have been delineated. The understanding of the important parameters controlling deposition processes has led to optimum specifications for coater design and process route such that high sphericity is maintained throughout coating with a minimum spread in coat properties. More recent detailed investigations of process variables have identified the factors controlling PyC microstructure and the effect that coat defects and substrate shapes have on the ability of SiC to contain the gaseous fission products released by the fuel kernel during in-reactor operation. The proportion of defective particles is reduced by establishing process specifications to minimize coating-kernel bonding and misshapen kernels.

8357 **Coated nuclear fuel particles: the coating process and its model.** Lefevre, R.L.R. (Belgonucleaire, Dessel); Price, M.S.T. *Nucl. Technol.;* **35**: No. 2, 263-278(Sep 1977).

The coating of nuclear fuel particles with pyrolytic carbon derived from a hydrocarbon gas is a complex process, and, until recently, although adequate behavior in service has been demonstrated, the methods used to obtain a particular product have been largely empirical. A concerted effort was made to close the loop: manufacture-quality-performance. A model of the decomposition process postulated the formation and growth of nuclei into agglomerates that are captured by the fuel particles. The evolution of the model involved many simplifications, and to reduce the number of variables involved, standardized operating conditions were assumed. The most important of these for comparative studies is the concept of operating at a constant reaction zone temperature. When this is done, many of the anomalies previously ascribed to the effect of

different source gases are removed. An experimental program has been carried out to test the model, and excellent correlations have been found between the predicted and actual size of agglomerates that can be observed in the coating structure. The agglomerate size has also been correlated with coating failure. With the aid of the model, similar deposits have been made from quite different source gases. A survey of the failure modes of coated particle fuel acts as an aid to deducing, in the light of the deposition model, the method of achieving a satisfactory quality assurance program for the structure of coatings on nuclear fuel particles.

8358 Automatic size analysis of coated fuel particles. Wallisch, K.; Koss, P. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). *Nucl. Technol.;* **35**: No. 2, 279-283(Sep 1977).

The determination of the diameter, coating thickness, and sphericity of coated fuel particles by conventional methods is very time consuming. Therefore, statistical data can only be obtained with limited accuracy. An alternative method is described that avoids these disadvantages by utilizing a fast optical data-collecting system of high accuracy. This system allows the determination of the diameter of particles in the range between 100 and 1500 μm, with an accuracy of better than +-2 μm and with a rate of 100 particles per second. The density and thickness of coating layers can be determined by comparing the data obtained before and after coating, taking into account the relative increase of weight. A special device allows the automatic determination of the sphericity of single particles as well as the distribution in a batch. This device measures 50 to 100 different diameters of each particle per second. An on-line computer stores the measured data and calculates all parameters required, e.g., number of particles measured, particle diameter, standard deviation, diameter limiting values, average particle volume, average particle surface area, and the distribution of sphericity in absolute and percent form.

8359 Influence of porosity on the irradiation performance of pyrocarbon coatings. Krautwasser, P.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 310-319(Sep 1977).

The pore-size distribution of pyrocarbon (PyC) coatings was measured by small-angle x-ray scattering. The method proved to be a very sensitive means of characterizing the microstructure of PyC's. Variations in deposition conditions--such as temperature, hydrocarbon gas, and gas flux-lead to distinct variations in pore-size distribution. Different pore-size intervals are related to such material properties as density and fracture stress as well as to the irradiation stability and gas permeability of low-temperature isotropic (LTI) coatings. A parametric property, the relative amount of fiber component, is derived from the pore-size distribution and correlated with the microstructural components of LTI coatings as well as with the irradiation performance.

8360 Properties of silicon carbide for nuclear fuel particle coatings. Price, R.J. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 320-336(Sep 1977).

The properties of pyrolytic silicon carbide (SiC) that are important to its use in nuclear fuel particle coatings are reviewed. The structure of material deposited under different conditions varies in growth features and the constituent phases; the principal effects of neutron irradition on the structure are to create point defect clusters at irradiation temperatures below approximately 1000°C (1273 K) and voids above approximately 1000°C (1273 K), with a concomitant volume expansion. The thermal conductivity is greatly reduced by neutron irradiation. Data are available for mechanical properties including Young's modulus, flexural strength, biaxial strength, and creep. Some useful results have followed from application of the Weibull model to strength measurements. The strength of single-phase beta-SiC is barely affected by neutron irradiation, but the strength of material containing excess silicon may be seriously reduced after irradiation. SiC has excellent resistance to oxidation as long as a surface film of silica is maintained. Diffusion of fission products is generally very slow, but it may be increased by structural imperfections.

8361 Preliminary examination of the helium permeability of pyrocarbon coatings. Morgan, C.S.; Powell, G.L. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **35**: No. 2, 337-339(Sep 1977).

Helium permeability of pyrocarbon (PyC) coatings of Biso fuel particles is evaluated by measuring helium content of fuel particles after heat treatment in a helium atmosphere. Fuel particles were annealed in a vacuum at 1800°C (2073 K) to remove any process helium before being annealed in a helium atmosphere. Helium release was monitored as the particles were individually broken in a vacuum chamber connected to a mass spectrograph sensitive to 10^{-14} mole of helium. Typical particles annealed in helium at atmospheric pressure contained 10^{-10} mole of gas. The inert gas content of the buffer layer is completely released when the PyC layer is cracked. Helium permeability was strongly temperature dependent and varied considerably with the properties of the PyC coating resulting from deposition conditions.

8362 Properties influencing high-temperature gas-cooled reactor coated fuel particle performance. Harmon, D.P.; Scott, C.B. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 343-352(Sep 1977).

Properties affecting the irradiation performance of outer pyrolytic carbon (PyC) layers on Triso- and Biso-coated fuel particles were studied. Irradiation temperatures were 1000 to 1500°C (1273 to 1773 K). Fast-neutron fluences reached 12.4 x 10^{25} n/m² (E greater than 29 fJ)/sub HTGR/, which is 55 percent beyond the large high-temperature gas-cooled reactor peak design exposure of 8.0 x 10^{25} n/m². Coatings with densities between 1.85 and 1.95 Mg/m³ and mean optical anisotropy values of equal to or less than 1.03 (BAF_0 units) exhibited the best irradiation performance on Triso particles. For Biso particles, it is necessary to deposit the outer layer at coating rates between 3 and 8 μm/min and with densities equal to or greater than 1.84 Mg/m³ to produce coatings impermeable to fission gases after irradiation. Data from fuel rod tests show that it is important to limit the degree of surface-connected porosity of the outer PyC layer and the amount of binder phase in the matrix to prevent coating failures resulting from coating-matrix interactions.

8363 Neutron-induced permeability of pyrocarbon-coated high-temperature gas-cooled reactor fuel particles. Bradley, R.A. (Oak Ridge National Lab., TN); Thiele, B.A. *Nucl. Technol.;* **35**: No. 2, 353-358(Sep 1977).

Fuel for the high-temperature gas-cooled reactor is in the form of microspheres surrounded by high-density impermeable coatings to retain fission products. Recent irradiation tests indicated that the high-density carbon layer of Biso coatings may become permeable to krypton, xenon, and CO during irradiation. In-reactor gas release measurements showed the particles were impermeable to fission gases at the beginning of the test, but released significant quantities of krypton and xenon after a period of irradiation. Although postirradiation examination by visual, ceramographic, and radiographic techniques indicated that all particles were intact, gas content measurement showed that particles receiving a significant fast fluence contained only a small fraction of the expected krypton and xenon, while those receiving low fluence retained almost all the fission gas. The results of these experiments indicate that the permeability of the coatings is due to fast-neutron-induced structural changes in the pyrocarbon.

8364 Mechanical behavior of Biso-coated fuel particles during irradiation. I. Analysis of stresses and strains generated in the coating of a Biso fuel particle during irradiation. Kaae, J.L. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 359-367(Sep 1977).

The stresses and strains generated in the outer pyrocarbon (PyC) coating of a two-layer Biso fuel particle coating during irradiation are analyzed to include very significant PyC property changes during irradiation. These property changes are not included in other analyses. The most significant change is in the anisotropy of the coating during irradiation and is related to irradiation-induced creep. A proposed method for calculating the effects of these anisotropy changes on irradiation-induced dimensional changes is supported by experimental data. Variations in Young's modulus and the creep parameters of the coating during irradiation are also included in the analysis. Particle failure probability is calculated with an extension of Weibull's analysis to the PyC coating.

8365 Mechanical behavior of Biso-coated fuel particles during irradiation. II. Prediction of Biso particle behavior during irradiation with a stress-analysis model. Kaae, J.L.; Bullock, R.E.; Scott, C.B.; Harmon, D.P. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 368-378(Sep 1977).

The initial crystalline anisotropy and density of the outer pyrocarbon coating of a two-layer Biso fuel particle have a very large effect on calculated diametral changes and coating failure probabilities during irradiation. Of the two, the anisotropy is by far the most important parameter affecting the coating failure probability. These effects arise because of variations in the irradiation-induced dimensional changes, irradiation-induced changes in crystalline anisotropy, and mechanical properties of pyrolytic carbons with these two structural parameters. In support of the stress-analysis model used for these calculations, predicted diametral changes of Biso-coated particles agree well with those observed in irradiation experiments.

8366 Improvement of a method for predicting failure rates of coated particles during irradiation. Bongartz, K. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 379-385(Sep 1977).

A method for calculating the coating stress distribution resulting from the statistical spread of geometrical parameters in irradiated fuel particle batches has been developed by Gulden et al. The existing method utilizing coated particles is extended in two ways: 1. A more realistic treatment of the buffer layer is adopted, taking into account its physical properties. 2. A statistical distribution according to Weibull has been adopted for the silicon carbide layer strength. Calculations with both the new and the old assumptions were performed on one feed particle and one breed particle type. It is

shown that the two modifications influence the results of the original method. It was found that the extension of the first assumption has no influence on the stress distribution and the fraction of breaking feed particles, but it changes the stress distribution of the breed particles significantly. The fraction of broken particles at end burnup is increased by a factor of approximately 10. The extension of the second assumption affects the fraction of broken feed as well as that of the breed particles. Depending on the Weibull parameter, m, the number of failed feed particles increases by a factor of 1.3 to 2; the corresponding factor for breed particles is between 3.5 and 60.

8367 Restoration of carbon monoxide equilibrium in porous oxide high-temperature reactor fuel particles. Strigl, A.; Proksch, E. (Forschungszentrum, Seibersdorf, Austria). *Nucl. Technol.;* **35**: No. 2, 386-391(Sep 1977).

For the purpose of postirradiation measurement of the amount of CO formed during irradiation of oxide high-temperature reactor fuel particles, the equilibrium between CO and the various oxide phases inside the kernel has to be reestablished as closely as possible. To this end, the particles have to be heated to irradiation temperature for a certain time. Kinetic measurements have been performed on two types of porous pure UO_2 kernels as well as on two types of porous carbon-diluted UO_2 kernels. At 1200°C (1473 K), the CO equilibrium is reestablished after some hours in all kernel types. There seems to be no significant influence of any particle or irradiation parameter on that time.

8368 Amoeba behavior of UO_2 coated particle fuel. Wagner-Loeffler, M. (Forschungszentrum, Seibersdorf, Austria). *Nucl. Technol.;* **35**: No. 2, 392-402(Sep 1977).

The data extracted from numerous irradiation tests were used to derive amoeba endurance parameters for UO_2. The data do not yet allow an unambiguous definition of the controlling mechanism, which may be due to either gaseous or solid-state diffusion processes. Adequate data on the amoeba effect are available for design of a steam-raising high-temperature gas-cooled reactor using UO_2 fuel.

8369 Migration of the ThO_2 kernels under the influence of a temperature gradient. Smith, C.L. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 403-412(Sep 1977).

Biso-coated ThO_2 fertile fuel kernels will migrate up the thermal gradients imposed across coated particles during high-temperature gas-cooled reactor (HTGR) operation. Thorium dioxide kernel migration has been studied as a function of temperature (1290 to 1705°C) (1563 to 1978 K) and ThO_2 kernel burnup (0.9 to 5.8 percent FIMA) in out-of-pile postirradiation thermal gradient heating experiments. The studies were conducted to obtain descriptions of migration rates that will be used in core design studies to evaluate the impact of ThO_2 migration on fertile fuel performance in an operating HTGR and to define characteristics needed by any comprehensive model describing ThO_2 kernel migration. The kinetics data generated in these postirradiation studies are consistent with in-pile data collected by investigators at Oak Ridge National Laboratory, which supports use of the more precise postirradiation heating results in HTGR core design studies. Observations of intergranular carbon deposits on the cool side of migrating kernels support the assumption that the kinetics of kernel migration are controlled by solid-state diffusion within irradiated ThO_2 kernels. The migration is characterized by a period of no migration (incubation period), followed by migration at the equilibrium rate for ThO_2. The incubation period decreases with increasing temperature and kernel burnup. The improved understanding of the kinetics of ThO_2 kernel migration provided by this work will contribute to an optimization of HTGR core design and an increased confidence in fuel performance predictions.

8370 Silicon carbide corrosion in high-temperature gas-cooled reactor fuel particles. Gruebmeier, H.; Naoumidis, A.; Thiele, B.A. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 413-427(Sep 1977).

The silicon carbide (SiC) layer in Triso-coated high-temperature reactor fuel particles is occasionally attacked during irradiation by fission products generated within the kernel material. Investigations to define the cause of the SiC corrosion included ceramographic, microradiographic, and microanalytical studies on irradiated and unirradiated coated particles of various kernel compositions. The results of these studies showed that the presence of chlorine within the particle, in combination with certain metallic fission products or uranium, can lead to corrosion of the SiC layer. These results provided the basis for establishing a model that relates the transport of fission products as volatile metal chlorides and their chemical reaction with the SiC coating. In addition, this model is consistent with the fact that under the influence of a thermal gradient, corrosive attack of the SiC occurs on the cooler side of the particle. The correlation between the occurrence of SiC corrosion during irradiation and heavy-metal transport observed in thermal gradient annealing studies of unirradiated particles of the same batch constitutes the basis for a new method for quality control.

8371 Stoichiometric effects on performance of high-temperature gas-cooled reactor fuels from the U—C—O system. Homan, F.J.; Lindemer, T.B.; Long, E.L. Jr., Tiegs, T.N.; Beatty, R.L. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **35**: No. 2, 428-441(Sep 1977).

Two fuel failure mechanisms were identified for coated particle fuels that are directly related to fuel kernel stoichiometry. These mechanisms are thermal migration of the kernel through the coating layers and chemical interaction between rare-earth fission products and the silicon carbide (SiC) layer leading to failure of the SiC layer. Thermal migration appears to be most severe for oxide fuels, while chemical interaction is most severe with carbide systems. Thermodynamic calculations indicated that oxide-carbide fuel kernels may permit a stoichiometry that reduces both problems to manageable levels for currently planned high-temperature gas-cooled reactors. Such stoichiometry adjustment is possible over the complete spectrum from UO_2 to UC_2 for the present recycle fuel, a weak acid resin (WAR)-derived fissile kernel. Thermodynamic calculations indicate that WAR kernels containing less than 15 percent UC_2 (greater than 85 percent UO_2) will develop excessive CO overpressures within the particle during irradiation. In 100 percent UO_2 particles, thermal migration and oxidation of the SiC layer were observed after irradiation. The calculations also indicate that WAR kernels containing greater than 70 percent UC_2 (less than 30 percent UC_2) contain insufficient oxygen to oxidize the rare-earth fission products formed in fuel operated to the maximum burnup levels of 75 percent fissions per initial metal atom (75 percent FIMA). Instead, the rare earths are present in part or completely as dicarbides. As such, they were observed to segregate from the kernel and collect at the SiC interface on the cold side of the particle, react with the SiC, and eventually fail this coating.

8372 Irradiation performance of Fort St. Vrain high-temperature gas-cooled reactor fuel in capsule F-30. Scott, C.B.; Harmon, D.P. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 442-454(Sep 1977).

Representative production fuel fabricated for the Fort St. Vrain (FSV) high-temperature gas-cooled reactor (HTGR) was tested in capsule F-30. The irradiation conditions experienced by the fuel encompassed the FSV service conditions designed for a 6-yr fuel cycle. Fuel specimens were irradiated at temperatures ranging from 825 to 1250°C (1098 to 1523 K) and to a peak fast-neutron exposure of 9.4×10^{25} n/m² (E greater than 29 fJ)/sub HTGR/, which is 18 percent beyond the design FSV peak fast-neutron exposure. In-pile fission gas release measurements and postirradiation examination indicated good irradiation stability of the fuel specimens. The 13 bonded fuel rods were intact, and their irradiation-induced dimensional changes were in good agreement with dimensional change curves used in the FSV core design. Total fuel particle failure fractions determined by visual examination, metallography, and fission gas release measurements were consistent with the criterion of less than 1 percent failure at peak exposure conditions assumed in FSV design and licensing evaluations. Fuel performance in the FSV reactor was evaluated using the capsule F-30 irradiation results. The good irradiation behavior of production fuel in this test gives a high degree of confidence in the performance of the FSV core throughout its lifetime and demonstrates the conservative nature of the FSV fuel particle design.

8373 Cesium release and transport in Biso-coated fuel particles. Morgan, M.T.; Malinauskas, A.P. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **35**: No. 2, 457-464(Sep 1977).

Theoretical and experimental aspects of cesium release from Biso-coated high-temperature gas-cooled reactor fuel particles are reviewed. Three types of transport are considered: diffusion through the pyrolytic carbon (PyC) coatings under conditions of a constant source potential, transport due to a continuously depleting source, and diffusion from a depleting source following constant source potential transport. Analysis of all of the release data obtained in this laboratory yields the following relations for the diffusion coefficient D/sub Cs/ characteristic of cesium transport through PyC coatings: For coatings deposited from propylene or propane at approximately 1250°C (1523 K): $D/\text{sub Cs/ (LTI)} = 1.68 \times 10^{2} \exp(-4.74 \times 10^{4}/T)$, (cm²/s) [$D/\text{sub Cs/ (LTI)} = 1.68 \times 10^{-2} \exp(-4.74 \times 10^{4}/T)$, (m²/s)], and for coatings deposited from methane at approximately 2000°C (2273 K): $D/\text{sub Cs/ (HTI)} = 5.7 \times 10^{-3} \exp(-3.50 \times 10^{4}/T)$, (cm²/s) [$D/\text{sub Cs/ (HTI)} = 5.7 \times 10^{-7} \exp(-3.50 \times 10^{4}/T)$, (m²/s)], where t is the absolute temperature.

8374 Cesium release data for Biso-coated particles. Stoever, D.; Hecker, R. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 465-474(Sep 1977).

Release data of cesium in Biso low-temperature isotropic (LTI) and high-temperature isotropic (HTI) coated particles are presented. Experimental and theoretical methods are briefly discussed. From the analysis of the experiments, kernel diffusion coefficients are calculated covering the kernel burnup range from 0.2 to 16 percent FIMA. At FIMA values equal to or less than 5 percent, cesium release is governed by the relatively low activation energy of

approximately 19 kcal/mole (79.6 kJ/mole), and even at temperatures as low as approximately 900°C (1173 K), kernel retention remains low. The outer pyrocarbon layer acts as the release rate controlling barrier for both LTI and HTI coatings. Diffusion coefficients in the temperature range from 1000 to 1500°C (1273 to 1773 K) for LTI coatings and 1250 to 1600°C (1523 to 1873 K) for HTI coatings have been derived. On the basis of the data, releases for high-temperature-reactor cores can be calculated.

8375 Release of metallic fission products from multilayered coated particles. Smith, P.D. (General Atomic Co., San Diego, CA); Steinke, R.G.; Jensen, D.D.; Hama, T. *Nucl. Technol.;* **35**: No. 2, 475-482(Sep 1977).

A model simulating the in-pile release of metallic fission prducts from a batch of coated fuel particles is based on a solution of the transient Fick's diffusion equation in a nonhomogeneous medium. It is developed in two stages. First, some representative analytic solutions for a single birth pulse in a single particle are numerically tabulated as functions of nondimensional parameters. Second, the solution for a history of continuously varying source, temperature, and particle failure fraction is obtained by interpolation and superposition. This permits use of the method as an efficient source subroutine in full-core release problems. The large number of physical parameters in the model provides adaptability in correlating and extrapolating experimental results. By using numerical examples, the model was shown to account for the following phenomena: recoil, transient diffusion response, transition from the intact to the failed state, and the effect of various rate-limiting mechanisms on the release.

8376 Silver release from coated particle fuel. Nabielek, H. (Kernforschungsanlage, Juelich, Ger.); Brown, P.E.; Offermann, P. *Nucl. Technol.;* **35**: No. 2, 483-493(Sep 1977).

The fission product /sup 110m/Ag released from coated particles can be the dominant source of radioactivity from the core of a high-temperature reactor in the early stages of the reactor life and possibly limits the accessibility of primary circuit components. It can be shown that silver is retained in oxide fuel by a diffusion process (but not in carbide or carbon-diluted fuel) and that silver is released through all types of pyrocarbon layers. The retention in Triso particles is variable and seems to be mainly connected with operating temperature and silicon carbide quality.

8377 Emission of fission gases by failed coated oxide fuel particles. Pointud, M.L.; Chenebault, P. (CEN, Grenoble, France). *Nucl. Technol.;* **35**: No. 2, 494-500(Sep 1977).

Radioactive fission gas release from coated particles containing UO_2 or (Th-U)O_2 fuel kernels was studied by taking into account the following parameters: (a) porosities of kernels and materials surrounding them, (b) irradiation temperature, (c) burnup, and (d) thermal neutron flux. The main results follow. First, the structure of the kernels is modified during irradiation and, consequently, the mechanism and rate of fission gas release vary. Second, for a dense fuel, released activity results from recoil species ejected by the external surface of the kernel and reemitted from the surrounding porous carbon. Finally, for an initially porous fuel or for a heavily irradiated dense fuel, recoil atoms reemitted from the internal open porosity of the kernel atoms ejected by knockout give the most important contributions to the release.

8378 Fission gas release from fuel particles and fuel rods. Myers, B.F.; Baldwin, N.L.; Bell, W.E. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 501-508(Sep 1977).

A review and analysis of available data on the release of fission gases from high-temperature gas-cooled reactor fuel particles indicates that the release of short-lived nuclides (half-life approximately less than 5.3 days) occurs from the fissile material primarily by a mechanism involving recoil followed by gas-phase and bulk diffusion in the surrounding material at temperatures up to at least 1300°C (1573 K). The gas-phase contribution to the release of short-lived nuclides is dominant at temperatures below 600°C (873 K), and bulk diffusion is dominant at temperatures above 900°C (1173 K). Fission gas release to birth ratio (R/B) varies with half-life to a power of approximately 0.2 at 300°C (573 K) and approximately 0.5 at 1100°C (1373 K). For the short-lived isotopes, R/B is independent of burnup over the range from 0 to 63 percent FIMA in UC_2 kernels; for dense ThO_2 kernels, the data are insufficient to determine the burnup dependence. For the long-lived and stable isotopes, release from dense ThO_2 kernels is strongly dependent on burnup. Iodine and tellurium isotopes may be treated as if they were xenon isotopes.

8379 Fission product release from coated particles embedded in spherical fuel elements for high-temperature reactors. Groos, E.; Mielken, G.; Duwe, R.; Mueller, A.; Will, M. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 509-515(Sep 1977).

The results of irradiation experiments on spherical fuel elements in the Studsvik R2 and the Juelich FR12 reactors are used to derive release data for both gaseous and metallic fission products. Fission gas release follows the well-known dependence on the square root of half-life showing that diffusion is the controlling release process for both intact and failed particles. The release of / sup 110m/Ag was generally about two orders of magnitude higher than that of ^{137}Cs. Profile measurements indicate good retention of strontium. Results of the concentration profile and in-pile release measurements allow verification of data from out-of-pile experiments.

8380 Release of rare fission gases from spherical elements with coated fuel particles. Roellig, K. (Hochtemperatur-Reaktorbau GmbH, Mannheim, Ger.). *Nucl. Technol.;* **35**: No. 2, 516-523(Sep 1977).

The release of the rare fission gases, krypton and xenon, from a high-temperature reactor pebble-bed core is predominantly determined by the heavy-metal contamination of the matrix material during manufactre. In the case of the Thorium High-Temperature Reactor prototype fuel, particles with failed coatings contribute greater than 10 percent to the total core release of the xenon and krypton isotopes with the exception of long-lived ^{85}Kr. In a series of irradiation experiments with spherical fuel elements, a linear relation between the gas release and the contamination of the matrix material was established. At mean fuel temperatures of 700°C (973 K), only approximately 1 percent of the /sup 85m/Kr and ^{133}Xe produced by fuel contamination is released. The experimental data for the steady-state release of 13 krypton and xenon isotopes can be explained by describing the graphitic matrix material as a two-component system. Component 1 is attributed to the graphitic grains of the raw material, and component 2 to the material between the grains, such as the amorphous, nongraphitized binder coke. The total contamination-induced release from the fuel elements is given by the retention characteristics of the two components working in parallel, followed in series by the gas-phase transport through the interconnected porosity of the fuel element structure. As a consequence of this model, the apparent activation energy for the steady-state release depends on the half-lives of the isotopes of the same species yielding, e.g., 5 kcal/mole (21 kJ/mole) for ^{140}Xe and 9 kcal/mole (38 kJ/mole) for ^{133}Xe.

8381 Improvements in the performance of nuclear fuel particles offered by silicon-alloyed carbon coatings. Kaae, J.L.; Sterling, S.A.; Yang, L. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **35**: No. 2, 536-547(Sep 1977).

Two-phase mixtures of pyrolytic carbon (PyC) and either silicon carbide or zirconium carbide are commonly called alloyed carbons and can be deposited on nuclear fuel particles by a combination of the well-known techniques of depositing carbon and the carbides. The silicon-alloyed carbons have properties that offer substantial improvements in coated-particle performance, while the zirconium-alloyed carbons that have been investigated have been found to be lacking in two of the properties essential for improved coating performance. The properties of the silicon-alloyed carbons that give rise to the improvements in performance are higher strength, smaller irradiation-induced dimensional changes, and a lower diffusivity for cesium than pure PyC's. These properties have significant implication to coated-particle design. Also, the silicon-alloyed carbons do not offer fundamental difficulties to the head-end of fuel reprocessing.

8382 Metallic fission product retention of coated particles with ceramic kernel additives. Foerthmann, R.; Gruebmeier, H.; Stoever, D. (Kernforschungsanlage, Juelich, Ger.). *Nucl. Technol.;* **35**: No. 2, 548-556(Sep 1977).

The retention of metallic fission products in coated particles with ceramic kernel additives is studied out-of-pile and in-pile. The ceramic additives are easily introduced without any significant change of kernel fabrication processes. The excellent efficiency of alumina-silica kernel additives for retaining ^{90}Sr and ^{140}Ba is demonstrated in-pile. The fractional release is reduced by two orders of magnitude. Silver-110m is not retained by the kernel additives. Cesium forms compounds in the alumina-silica additives, which become unstable at temperatures above 1400°C (1673 K). At normal high-temperature gas-cooled reactor operation temperatures [1000 to 1200°C (1273 to 1473 K)], the diffusion coefficient of cesium in oxide kernels with alumina-silica additives is reduced by about two orders of magnitude.

8383 Coated particle fuels. Nickel, H. (Kernforschungsanlage, Juelich, Ger.); Gulden, T.D. *Nucl. Technol.;* **35**: No. 2, 567-573(Sep 1977).

Some highlights of coated fuel particle research are discussed in an attempt to put the current state of the technology in perspective and to indicate directions for future work.

8384 (ORNL-tr—4413) **Fuel cycle for the gas-cooled high temperature reactor.** Merz, E. Translated from *Chem. Ztg.;* **101**: No. 2, 81-91(1977). 21p. Dep. NTIS, PC A02/MF A01.

The marked shortage of fossile raw materials already being felt today will, in the future, lead to an increased use of nuclear reactors for the generation of energy. This will open up great

possibilities, in particular for the high-temperature reactor which is capable of providing not only electric energy but also process heat. However, in order to take advantage of this possibility, major efforts are still required with a view to closing the fuel cycle. This contribution gives an outline of the present state of development work in the Federal Republic of Germany. Besides refabrication and radioactive waste management, interest is concentrated on reprocessing as a first partial step. It plays a certain key role, for it is not only a prerequisite for recycling unspent or newly formed fissile material, required for economic reasons, but, at the same time, constitutes the initial step in the process of transforming highly radioactive fission products to safe forms for ultimate storage.

8385 Material problems of high temperature nuclear reactors cooled with gas helium (HTGR). Emmerich, R. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). *Zesz. Nauk. Akad. Gorn.-Hutn. Stanisl. Staszica, Mat., Fiz., Chem.;* No. 23, 101-111(1975). (In Polish).

A short review is pesresented of writings concerning research and selection of optimum materials of the most important construction elements of high temperature nuclear reactors cooled with helium. Construction projects of this type of reactors assume that for economical reasons their service life ought not be shorter than 30-40 years. For these reasons there are elaborated new construction materials being subject to comprehensive technological tests. It results from experimental and theoretical works carried on in foreign centres and from observation of work of the first experimental reactor of this type in Peach Button (USA), that materials working in surroundings of high temperatures, pressures, and high speed of coolant flow and high streams of nuclear radiation, especially of fast neutrons, are subject to degradation in different ways. Especially many works deal with influence of radiation on defects of materials and alloys used for construction of reactor core elements and of installations being in its closest neighbourhood. Investigation of influence of helium impuritis on corrosion of constructional materials of cooling cycle is also an important problem drawing much attention. Interest in possibility of utilization of the high temperature nuclear reactor cooled with helium for technological heat production for direct coal gasification or iron ore reduction developed wide research on influence of heat collecting factor on technological properties of constructional materials of heat exchangers.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 8450, 8465, 8478, 8481, 8486, 8488, 8489, 8490, 8491, 8492, 8493, 8494, 8495, 8509, 8512, 8513, 8514, 8515, 8516, 8517, 8518, 8519, 8520, 8521, 8524, 8536, 8537, 8538

8386 (ANL—77-15) **THI3D-1: a computer program for steady-state thermal-hydraulic multichannel analysis.** Sha, W.T.; Schmitt, R.C.; Lin, E.I.H. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 107p. .

THI3D-1 is an improved version of the THI3D computer program for steady-state, single-phase, thermal-hydraulic multichemical analysis. The program accounts for conservation of mass, energy, and momentum subject to pressure-drop boundary conditions, and leads to a nonlinear multipoint boundary-value problem. Turbulent interchange, radial thermal conduction, and forced flow due to wire wraps or grids between channels are explicitly taken into account. Temperature distributions in the coolant, cladding, fuel, and duct wall and the size of the central void of the oxide fuel after thermal restructuring are computed. Three different thermal-hydraulic channel arrangements (square, hexagonal, and triangular can be treated. Multipin analysis with transverse interactions or multiassembly calculations without transverse interactions between the channels can be performed. In addition, (1) a new wire-wrap model has been developed that accounts for most measured mixing data in a wire-wrapped rod bundle; (2) bypass fluid of a fuel assembly is accounted for; (3) an implicit option for the energy equation is provided (this option is necessary for low Reynolds number flow); and (4) an improved transverse-momentum equation is incorporated. Also included are program-input description and format, and a sample problem reflecting these improvements.

8387 (CRBRP-ARD—0168) **Clinch River Breeder Reactor Plant. Impace of fuel densification on CRBRP fuel performance.** Bishop, B.A. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jun 1977. Contract EY-76-C-14-2395. 63p. TIC.

A review of both LWR and LMFBR mixed-oxide fuel literature shows that fuel densification mechanisms are similar. The primary factor is unirradiated porosity and the associated fuel microstructure. If fuel densification were to become a problem in CRBRP, there is substantial evidence in the literature that densification could be controlled by changes in the fuel manufacturing process. Based upon low burnup FFTF vendor fuel data, which is CRBRP prototypic, and high burnup nonprototypic data, which overpredicts CRBRP densification, from the EBR-II Reference Fuels Irradiation Program, a conservative design bases for CRBRP fuel densification was derived. The maximum CRBRP fuel pellet length decrease was set at 0.4 to 1.1% at 15 to 21 MWd/Kg local fuel burnup. These values were shown to envelop or exceed the values in the published literature. The maximum column shortening in the peak power fuel rod was 0.352 inches while the core average value is 0.220 inches.

8388 (CRBRP-ARD—0175) **Clinch River Breeder Reactor Plant. MAXPRES-2: computer code verification.** Ranatza, S. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jul 1977. Contract EY-76-C-15-2395;EY-76-C-15-1200;EY-76-C-15-0003. 31p. .

During an energetic LMFBR Hypothetical Core Disruptive Accident (HCDA), the rapid expansion of the HCDA bubble would accelerate the slug of sodium above the core. As the sodium rises, the argon cover gas would be compressed. After the sodium slug impacts the reactor vessel closure head, the sodium would penetrate the spaces within the head structure and the head-mounted component annuli. The argon cover gas in the annuli would be further compressed by the penetrating sodium. The MAXPRES-2 code analyzes the argon and sodium flow in the annuli to determine maximum annuli pressures and, ultimately, the capability of various seals and annuli geometries for mitigation of HCDA consequences. During the development of the code, various comparisons and checks were made to verify that the code programming and formulation accurately represented the mathematical model. Two of these comparisons and checks which were made to the key parts of the code are described in detail. A comparison was made between a separately programmed simplified computer calculation (MPCK) and MAXPRES-2 to check the integration subroutine and the momentum equation subroutine. A separately programmed simplified calculation (AFLOCK) of gas flow equations was made to check the MAXPRES-2 AFLO subroutine.

8389 (DLCS—5000277) **[Shippingport Atomic Power Station]. Quarterly operating report, second quarter 1977.** (Duquesne Light Co., Shippingport, Pa. (USA)). 1977. Contract EY-76-C-11-0292. 14p. Dep. NTIS, PC A02/MF A01.

A summary is presented of Shippingport reactor operation, and data are provided on water chemistry, reactor maintenance, and test procedures. (DG)

8390 (FEI—556) **Experimental study on interchannel interaction of coolant in rod lattices with wire-wrap spacers.** Zhukov, A.V.; Kotovskii, N.A.; Matyukhin, N.M.; Sviridenko, E.Ya.; Sorokin, A.P.; Ushakov, P.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1975. 26p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Experimental study results for interchannel mixing in rod assemblies with wire spacers are presented. Particular attention is given to the analysis of interchannel interaction local processes found by measuring temperature profiles along the assembly length. The results of experimental study are compared with precomputed data on the basis of local and effective interchannel mixing models. A systematization is provided of data on the effective mixing coefficients for the rod assemblies in the liquid metal flows. Relations for local and effective mixing coefficients are recommended.

8391 (HEDL—6232) **Program outline under-sodium viewing.** Hoitink, N.C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-14-2170. 8p. .

An outline is presented of a program with the following objectives: (1) provide technical management and required basic development for completing the design, fabrication, and Composite Reactor Component Test Activity (CRCTA) testing of a prototype Under-Sodium Viewing (USV) system and complete all necessary modifications to the prototype system and make available for FFTF use; (2) identify the under-sodium viewing and ranging requirements for the Clinch River Breeder Reactor (CRBR) and develop the special ultrasonic concepts, techniques, and equipment needed to satisfy these requirements; and (3) develop transducers, electronics, and mechanisms to improve reactor inservice inspection capabilities. Specific improvements include image enhancement, in-vessel storage of future USV systems and real time imaging. Advanced systems will provide capability for inservice inspection and surveillance.

8392 (HEDL-SA—897) **Bundle-duct clearance of HEDL mixed oxide subassemblies.** Hill, R.G.; Jackson, R.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract EY-76-C-14-2170. 17p. (CONF-761103—31). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; Washington, District of Columbia, United States of America (USA) (15 Nov 1976).

One parameter of interest bearing upon LMFBR fuel pin performance is the "clearance" between the fuel pin bundle and its associated duct. This clearance is determined by calculating the

distance between a theoretically tight bundle and the inner surface of the duct wall. Because the individual fuel pins have varying amounts of bending and bowing, the pin bundle is a springy array which expands to fill the duct. Therefore, the calculated clearance exists as a somewhat randomly distributed porosity throughout the pin bundle. A computer code is described which calculates the amount of clearance which is distributed. This computer code, POROSITY, considers the mechanisms of thermal expansion, neutron induced swelling, and creep. These mechanisms each cause a dimensional change in the fuel pin bundle and duct.

8393 (HEDL-SA—1167) **Stress-affected microstructural development and creep-swelling interrelationship.** Brager, H.R.; Garner, F.A.; Gilbert, E.R.; Flinn, J.E.; Wolfer, W.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1977. Contract EY-76-C-14-2170. 48p. (CONF-770641—12). Dep. NTIS, PC A03/MF A01.

From Conference on radiation effects in breeder reactor structural materials; Scottsdale, Arizona, United States of America (USA) (19 Jun 1977).

Macroscopic measurement of the deformations arising from swelling and creep during neutron irradiation indicate that both processes are dependent on the magnitude and possibly the sign of the applied stress state. Current modeling efforts also indicate that a strong interaction exists between swelling and creep through the stress state. Because the macroscopic distortions arise from the integrated microscopic strains associated with specific microstructural elements, the effect of applied stress on microstructural development has been studied.

8394 (HEDL-TME—77-53) **ENERGY 1A: a modified version of the ENERGY 1 thermal-hydraulic computer code for LMFBR wire wrap spacer fuel assemblies.** Shearer, D.M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-14-2170. 42p. .

ENERGY 1A is a modification of the ENERGY 1 thermal-hydraulic computer program developed at MIT. ENERGY 1A is useful for thermal-hydraulic sensitivity studies of large liquid metal fast breeder reactor fuel pin assemblies. The program is simple, easy to use, fast running, and readily accommodates large fuel pin assemblies with a minimum of input data. Calibration of ENERGY 1A is easily accomplished with experimental results or thermal-hydraulic results from a more rigorous computer program. For a flow solution given by a few input variables and input values for fuel pin energy generation ENERGY 1A predicts coolant and cladding midwall temperatures throughout the fuel pin assembly.

8395 (KFK—2416, pp 109-111) **Carbide fuel element for the reload of the KNK-II.** Bojarsky, E. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

Within the framework of the study on the irradiation behaviour of carbide fuel rods, complete carbide fuel elements are to be tested in the fast neutron flux of the KNK II. The main data and the construction of the carbide fuel elements are presented. Some data of the KNK II carbide elements with regard to thermo-hydraulics are compared with the data of an oxide element of the type Mark II.

8396 (KFK—2416, pp 80-88) **Status of development of cladding and structural materials for the SNR core elements.** Dietz, W. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

Problems concerning high-temperature plasticity and the swelling of cladding and fuel channel materials of the SNR-300 are dealt with. Plasticity of the material 1.4970 under short-term and long-term stress (10^4h), the 0.2% yield point, and elongation before reduction of area of the irradiated material as well as creep rupture strength and the 0.2% creep limit of pipes made of 1.4970 (t = 700°C, irradiated and non-irradiated) are presented in diagrammes. Creep induced by irradiation of the materials 1.4970 and 1.4981 is also dealt with.

8397 (KFK—2416, pp 96-101) **Technology of the production of breeder fuel elements.** Funke, P. (Alpha Chemie und Metallurgie G.m.b.H. (ALKEM), Hanau (Germany, F.R.)). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

A survey is presented of the fabrication of oxide and carbide fuels and of the fuel rod for fast breeders (KNK, SNR-300). The advantages of the chosen methods are explained. The main points of development concerning the oxide fuel rod are gone into. The process sequence for plutonium oxide and plutonium carbide processing is presented in a flow chart.

8398 (KFK—2416, pp 12-18) **SNR-Cores: KNK-II, SNR-300 up to SNR-2.** Hoechel, J. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

The focal points in the development of fast breeder core design are outlined briefly, and the main data of the cores Na-2, SNR-300 MK-I, SNR-300 MK-Ia and SNR-300 MK-II are presented in tabular form. Steel 1.4970 is named as a new reference material for SNR fuel elements.

8399 (KFK—2416, pp 19-26) **Fuel elements for breeder power plants. International status.** Kummerer, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

A survey is presented of 21 fast breeder reactors which are either already in operation, under construction, or in a concrete stage of planning. Design and operational data of the fuel rods and fuel elements of these reactors are given in tabular form. A synopsis reveals common aspects and differences in the line of development of the various countries.

8400 (KFK—2416, pp 60-70) **Status of the development of the carbidic fuel element.** Muehling, G. 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

The carbide irradiation programme for developing carbide fuel elements for the SNR-300, one of the programme items of the Gesellschaft fuer Kernforschung, Karlsruhe, is introduced. It is subdivided into 2 phases: in phase 1, individual rod irradiation is carried out in the thermal reactors FR-2 and BR-2. Phase 2 includes the focal points: cluster irradiation under rapid flux and tests concerning the incident behaviour of carbide rods. Irradiations carried out so far demonstrate that the swelling of fuel and can can be got under control if the design is right.

8401 (KFK—2416, pp 38-41) **First drafts of core and fuel elements for the SNR-2 reactor.** Spenke, H.; Wehmann, U. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

8402 (KFK—2416, pp 102-108) **Design of carbide fuel rods.** Steiner, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). 1976. (In German).

From 5. space optics meeting; Marseille, France (14 Oct 1975).

In Fuel element of the LMFBR.

The model theory for the design of carbide fuel rods, unlike that of the oxide fuel rod, is considered to be not yet fully developed. Therefore, one falls back on empirical material from irradiation experiments. The paper is concerned with thermal design, the swelling of carbide fuel, and the mechanical interactions of the system fuel/can. The following problems are dealt with in this connection: The space between fuel and can as a heat barrier, the temperature drop in the carbide pellet, model calculations on heat transfer, a rupture study of the carbide pellet, the stretching of cans during irradiation experiments, integral swelling rates, swelling pressure and creep deformation of cans.

8403 (KFK—2416, pp 72-79) **Chemical and mechanical interaction in the oxide fuel rod.** Thuemmler, F.; Dienst, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

A survey is presented of chemical and mechanical interactions between mixed oxide fuel and can material, whereby the problems of fuel rod behaviour under load changes are dealt with in more detail. It is found that in all cases of cladding tube cracking internal corrosion plays a role.

8404 (LA—6924-PR) **Examination of fast reactor fuels, FBR analytical quality assurance standards and methods, and analytical methods development: irradiation tests. Progress report, April 1—June 30, 1977.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., N.Mex.

(USA)). Aug 1977. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

Characterization of unirradiated and irradiated LMFBR fuels by analytical chemistry methods will continue, and additional methods will be modified and mechanized for hot cell application. Macro- and microexaminations will be made on fuel and cladding, using the shielded electron microprobe, emission spectrograph, radiochemistry, gamma scanner, mass spectrometers, and other analytical facilities. New capabilities will be developed in gamma scanning, analyses to assess spatial distributions of fuel and fission products, mass spectrometric measurements of burnup and fission gas constituents and other chemical analyses. Microstructural analyses of unirradiated and irradiated materials will continue, using optical and electron microscopy and autoradiographic and x-ray techniques. Analytical quality assurance standards are designed to assure the quality of the chemical characterizations necessary to evaluate reactor components relative to specifications. Tasks include: (1) the preparation and distribution of calibration materials and quality control samples for use in quality assurance surveillance programs, (2) the development of and the guidance in the use of quality assurance programs for sampling and analysis, (3) the development of improved methods of analysis, (4) the preparation of continuously updated analytical method manuals, and (5) maintenance of referee analysis capabilities to characterize on a reimbursable basis, materials in dispute between fabricators (vendors) and reactor operators (purchasers). Highly reliable analytical methods for the measurement of burnup, various gases, and trace impurities in irradiated fuels are also being developed.

8405 (ORNL/TM—5992) **Analyses of TSF experiments on radiation heating in a stainless steel-sodium CRBR radial shield mockup using a 32-inch diameter collimated beam source.** Maerker, R.E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 60p. .

Analyses of the second phase of the radiation heating experiments performed at the Tower Shielding Facility have been made where the emphasis was placed on investigating the accuracy of TLD measurements in mockups of the CRBR radial shield. In particular, it is concluded that with the aid of flux calculations described in this report the corrections to both the Li^7F and CaF_2 TLD measurements are well enough understood that the TLD measurements can be brought into +-3% agreement with both ion chamber measurements and with each other. The accuracy of the gamma-ray calculations is limited by the accuracy of the 51 neutron group transport calculations; the production cross sections present in ENDF/B-IV are adequate for ^{238}U, sodium, and stainless steel.

8406 (WARD-CR—3045-20) **National core restraint development program: seven row test results.** Thomson, J.D. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Sep 1977. Contract EY-76-C-02-3045-005. 53p. .

The paper describes a test program required to develop the technology necessary to design breeder reactor core restraint systems and support applicable licensing processes. The basis for the qualification of analytical models is described and evaluated relative to the test results. Basic characteristics of the behavior of core assembly arrays are revealed through the implementation of special test methods. An understanding of the mechanical interactions of fuel assemblies in an array is necessary to qualify an analytical model for use as a design tool. "In air" tests were conducted to aid in developing a qualified model. These tests were designed utilizing test components closely configured to the dimensional, elastic and frictional characteristics of breeder reactor core assemblies in sodium. Comparisons are made between the test results and predictions from an analytical model of the 7 Row test facility. The test facility was modeled using engineering approximations and assumptions characteristic of core restraint design practices. The report, the first of two reports, provides test results from the Westinghouse Core Restraint Test Facility (WCRTF). The report provides information and evaluation on the seven row core array for the following subjects: (1) generalized compaction characteristics, (2) uncertainties related to prediction of core array behavior, (3) comparisons between empirical data and analytical predictions, and (4) statistical modeling basis for core restraint analysis twist effects on core compactions. The results of the evaluation are discussed in terms of additional effort required to fully characterize the effects of mechanical interactions.

8407 (WARD-D—0147) **Internal external cladding degradation.** Travis, M.L. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Feb 1977. Contract EY-76-C-02-3045-020. 66p. .

The purpose of the report is to provide information on Internal/External Cladding Degradation. Cladding degradation is used to denote both material loss and degradation of properties due to the high temperature sodium environment and the presence of fuel at high burnups. Various cladding degradation mechanisms that have been identified include: (a) loss of material and surface depletion (chromium and nickel) due to sodium corrosion, (b) degradation of material strength due to loss of carbon and nitrogen, (c) loss of material due to fretting and wear, and (d) internal cladding attack by redistributed fission products.

8408 **Generalized parametric model for transient gas release and swelling in oxide fuels.** Gruber, E.E. (Argonne National Lab., IL). *Nucl. Technol.;* **35**: No. 3, 617-634(Oct 1977).

The need for a capability to predict transient fission gas behavior arises because of the complexity of fission gas response to transient conditions, the importance of fission gas to fuel mechanical response, and the prevalent limitations on experimental information relevant to the problem. A detailed mechanistic analysis of intragranular swelling and release of gas from grains to grain boundaries, both as they result from transient heating, has been developed and incorporated in a fission gas release and swelling code (FRAS). A generalized parametric model to approximate the results that would be obtained from the more detailed calculations has also been developed. The need for this model arises from the necessity to consider the fission gas effects in more general multinode accident-analysis and pin-mechanics codes. For such calculations, the FRAS code is prohibitive in its demands on computer storage and execution time, while the parametric FRAS (PFRAS) code reduces these demands by an order of magnitude. Transient calculations have been carried out with both codes, both to illustrate the sensitivity of the results to the parameters and to indicate the level of confidence that can reasonably be ascribed to PFRAS results. The parameters considered include initial gas concentration, grain size, heating rate, thermal gradient, and pressure. The PFRAS model gives a satisfactory approximation to FRAS results for the broad range of parameters surveyed.

8409 **Thorium-based fuels in fast breeder reactors.** Sehgal, B.R.; Naser, J.A.; Lin, C.L.; Loewenstein, W.B. (Electric Power Research Inst., Palo Alto, CA). *Nucl. Technol.;* **35**: No. 3, 635-650(Oct 1977).

A number of thorium-based fuels for fast breeder reactors using either sodium or helium coolant are considered. Thorium-plutonium mixed-oxide fuels have similar or slightly better material properties than those for mixed uranium-plutonium oxides. Their thermal performance is also very similar to that of the UO_2—PuO_2 mixed-oxide fuel. Their nuclear performance shows a substantially lower breeding gain, but a much lower positive sodium void coefficient than those for the UO_2—PuO_2 system. The material properties of Th-U-Pu and Th-U metal alloys are more suitable for reactor application than those of the uranium metal alloy. The Th-U-Pu metal alloy system has higher breeding gain, much lower positive sodium void coefficient, and a possibly higher negative Doppler coefficient of reactivity than the magnitude of those parameters for the UO_2—PuO_2 system. The Th-^{233}U metal alloy system has a slightly lower breeding gain than the UO_2—PuO_2 system, but it has a negative reactivity coefficient for sodium voiding from the core. Equilibrium fuel cycle calculations reveal that all of the thorium metal alloy systems have a longer cycle length than the UO_2—PuO_2 system for the same burnup constraint. Thermal-hydraulic calculations show that sodium-bonded thorium metal alloy fuel elements may be able to operate up to an approximate 82 kW/m (25 kW/ft) peak power rating in sodium coolant.

8410 **Interactions of refractories and reactor materials with sodium.** Fink, J.K.; Heiberger, J.J.; Kumar, R.; Blomquist, R.A. (Argonne National Lab., IL). *Nucl. Technol.;* **35**: No. 3, 656-662(Oct 1977).

As part of a program at Argonne National Laboratory (ANL) to investigate the compatibility of high-temperature sodium with materials being considered for core retention systems in liquid-metal fast breeder reactors, various commercial refractories and samples of reactor control materials were exposed to static sodium at 850°C for 5 h. The refractories tested were samples of magnesia, alumina, zirconia, mixed ceramic oxides, and graphite; the reactor control materials were boron carbide and tantalum. Samples of graphite, zirconia, and the refractories with high alumina or magnesia contents, but with low silica and chromic oxide contents, were found to be compatible with high-temperature sodium. Sample compatibility with sodium decreased with an increase in the silica content of the sample. Samples with large silica content failed completely. These results are in good agreement with results of other experiments, performed at ANL and at the Westinghouse Advanced Reactors Division, in which these materials were exposed to boiling sodium.

8411 **Elastic—plastic analysis of pressurized ducts with rounded corners.** Petroski, H.J. (Argonne National Lab., IL). *Nucl. Technol.;* **35**: No. 3, 671-676(Oct 1977).

The strength of a reactor subassembly duct depends on its cross section and its material properties. Straight- and curbed-beam theories have been used to analyze ducts with elastic-perfectly-plastic material behavior, and this analysis has been found to be suitable and convenient for parametric studies. The strengths of hexcans with different corner radii have been compared, and the stiffening effect of increasing radius has been quantified. The relative strengths of different duct cross sections have also been determined.

8412 (BNWL-tr—265) **Results on an irradiation experiment on absorber materials for fast sodium-cooled reactors.** Hoerle, M.; Enderlein, H.; Pejsa, R.; Duenner, P. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 20 Sep 1977. Translation of AED-Conf—1976-013-195. (CONF-760359—6). 8p. Dep. NTIS, PC A02/MF A01.

From Reactor meeting; Duesseldorf, German, Federal Republic of (F.R. Germany) (30 Mar 1976).

Some results concerning helium release, dimensional stability, swelling, density change, and cladding compatibility of irradiated LMFBR absorber materials are presented. The materials included B_4C, Eu_2O_3, and EuB_6.

8413 **Structure for reducing convection currents within the pressure vessel of a fast reactor.** Benque, J.P.; Lallement, J.; Lambert, P. (to Commissariat a l'Energie Atomique). US Patent 4,043,867. 23 Aug 1977. Priority date 3 Sep 1974, France. 4p.

A hollow metallic ring structure is secured to the periphery of the diagrid support and located within an internal annular space formed between the lateral neutron shield of the reactor core and an inner tank placed within a primary vessel. The ring structure is smaller in width than the annular space, has a maximum height equal to that of the reactor core, and is provided with partition-walls and holes for producing pressure drops and reducing convection currents.

8414 **US utilities argue for the breeder and reprocessing.** Knox, R. *Nucl. Eng. Int.;* **22**: No. 258, 29-30(Jun 1977).

The 1977 American Power Conference provided an immediate opportunity for electric utilities to make known their reactions to President Carter's nuclear policy statements. Continued development of the fast reactor, Pu cycle and reprocessing were all considered essential. A nuclear power reactor was the most difficult way of producing plutonium for bombs.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

8415 (LA—6939-MS) **Conceptual design of a heat pipe radiator.** Bennett, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 13p. Dep. NTIS, PC A02/MF A01.

A conceptual design of a waste heat radiator has been developed for a thermoelectric space nuclear power system. The basic shape of the heat pipe radiator was a frustum of a right circular cone. The design included stringer heat pipes to carry reject heat from the thermoelectric modules to the radiator skin that was composed of small-diameter, thin-walled cross heat pipes. The stringer heat pipes were armored to resist puncture by a meteoroid. The cross heat pipes were designed to provide the necessary unpunctured radiating area at the mission end with a minimum initial system mass. Several design cases were developed in which the individual stringer survival probabilities were varied and the radiator system mass was calculated. Results are presented for system mass as a function of individual stringer survival probability for six candidate container materials, three candidate heat pipe fluids, two radiator operating temperatures, two meteoroid shield types, and two radiating surface cases. Results are also presented for radiator reject heat as a function of system mass, area, and length for three system sizes.

REGULATION AND LICENSING

8416 **Licensing of nuclear power facilities construction.** Svab, J. *Spravni Pravo.;* **9**: No. 5, 275-282(Aug 1976). (In Czech).

Act No. 50/1976 of 27 April 1976, on regional planning and building regulations which came into force as from October 1, 1976 makes the decision on the siting of a nuclear installation, the issuing of a construction and an operating licence conditional on the approval of the Czechoslovak Atomic Energy Commission. The Commission issues its statement on the basis of an analysis of nuclear safety reports. The implementing provisions also contain general technical demands on the construction of nuclear power installations.

8417 (NUREG—0200) **Improving regulatory effectiveness in Federal/State siting actions: Federal/State regulatory permitting actions in selected nuclear power station licensing cases.** Baroff, J. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of State Programs). Jun 1977. 143p. NTIS $6.75.

The Federal/State regulatory permitting actions in 12 case histories of nuclear power station licensing in nine different states are documented. General observations regarding Federal/State siting roles in the siting process are included. Eleven of the case histories are illustrated with a logic network that gives the actions of the utilities in addition to the Federal/State permits.

8418 (PB—268350) **Reducing nuclear power plant leadtimes: Many obstacles remain: Nuclear Regulatory Commission. Report to the Congress.** (General Accounting Office, Washington, D.C. (USA). Energy and Minerals Div.). 2 Mar 1977. 25p. (EMD—77-15). NTIS PC A02/MF A01.

Today's large nuclear powerplants cost from $700 million to $1 billion to construct. Much of this cost--up to 40 percent, according to one study--is interest and inflation encountered during the 10 or more years of leadtime--the timespan from the date a utility decides to build a plant until the date it becomes operational. Presently, high capital costs have contributed to many utilities' decisions to defer or cancel construction of planned units. Thus, the leadtimes for constructing nuclear powerplants are important factors in the economics of nuclear power, and any reductions in the present 10-year cycle would reduce capital costs and enable a utility to more quickly begin recovering the cost of the plant. Reduced leadtimes would also provide earlier on-line electrical power to meet increased energy demands. For several years the President and the Joint Committee on Atomic Energy have been concerned about the lengthy leadtimes and the President has requested the Nuclear Regulatory Commission to take steps to reduce them. NRC has in recent years implemented certain administrative changes in an attempt to reduce nuclear powerplant leadtimes from 10 years to 7 to 8 years without compromising safety.

8419 (PB—269313) **Instructions for preparation of data entry sheets for Licensee Event Report (LER) file. Revision 1. Instruction manual.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Management Information and Program Control). Jul 1977. 113p. (NUREG—0161). NTIS PC A06/MF A01.

The manual provides instructions for the preparation of data entry sheets for the licensee event report (LER) file. It is a revision to an interim manual published in October 1974 in 00E-SS-001. The LER file is a computer-based data bank of information using the data entry sheets as input. These data entry sheets contain pertinent information in regard to those occurrences required to be reported to the NRC. The computer-based data bank provides a centralized source of data that may be used for qualitative assessment of the nature and extent of off-normal events in the nuclear industry and as an index of source information to which users may refer for more detail.

8420 (PB—269385) **Improving regulatory effectiveness in Federal/State siting actions. Success factor evaluation panel. Final report.** Haggard, J. (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jun 1977. 130p. NTIS PC A07/MF A01.

An independent appraisal of the factors that determine efficiency in reaching environmental decisions with respect to nuclear facilities was addressed. The Panel recommended to substitute 'effectiveness' for 'efficiency.' Thus, an effective decision is: 'A timely final decision, that provides for necessary change, consistent with societal objectives and law, and which is equitable and practical, and is based upon fully and candidly expressed premises utilizing a commonly available data base.' The measurement criteria for evaluating the effectiveness of the environmental decision making process are: timely decision, final decision, provision for change, consistency with societal goals and law, equitable, practical, fully and candidly expressed premises, commonly available data base, and public confidence. The Panel evaluated the 8 policies proposed by NRC staff as essential to licensing reform: national fuels policy, regional review, early disclosure, State role, technical assistance to State, role of utilities, radiation health and safety, and modification of the Atomic Energy Act. The five NRC scenarios were evaluated in terms of regulatory effectiveness.

8421 (PB—269386) **Improving regulatory effectiveness in Federal/State siting actions. Environmental planning and the siting of nuclear facilities: the integration of water, air, coastal, and comprehensive planning into the nuclear siting process. Final report.** Noble, J.B.; Epting, J.T.; Blumm, M.C.; Ackerman, S.; Laist, D.W. (Center for Natural Areas, Washington, D.C. (USA)). Jun 1977. 218p. NTIS PC A10/MF A01.

The use of the National Environmental Policy Act (NEPA) as a positive tool for effective nuclear facilities siting is suggested as a means of assuring that States do not ignore the national interest in energy facilities siting when formulating their environmental programs. Also, the Study includes a legal/institutional analysis of four major Federal programs which affect the siting of nuclear facilities through the establishment of Federal/State/regional planning processes: Coastal Zone Management Act, Federal Water Pollution Control Act, Clean Air Act, and Housing and Community Development Act. Once implemented, these planning processes will exert a considerable influence over the siting of nuclear facilities. Thus, a need is shown for a mechanism to make the siting processes more effective. Three ways are identified: by NRC review and comment on environmentally related programs; and by NRC providing strong incentives to its applicants to consult with and coordinate their activities with responsible State planning entities before submitting applications.

8422 (PB—269387) **Improving regulatory effectiveness in Federal/State siting actions. State regulatory activity involved in need for power. Final report.** Massikas, J.N. (Cox, Langford and Brown, Washington, D.C. (USA)). Jun 1977. 57p. NTIS PC A04/MF A01.

This synopsis gives the individual views of the panel members relating to the basic issues and framework for improvements of the Federal/State process for licensing of nuclear power stations, associated facilities, transmission lines, reprocessing of fuel and uranium enrichment. The panel concluded that the need for power should be determined by the States. The panel believed that: (1) a national energy policy is necessary to enable planning based on the predictable and certain principles; (2) caution should be exercised in regional review of electric system plans and alternatives; (3) early disclosure of plans involving sites and rights-of-way are necessary; (4) there should be a higher level of State activity; (5) there should be technical assistance to the States; (6) industry should continue in a strong role; (7) radiation health and safety issues should be retained under NRC control; (8) there should be advanced certification of environmentially suitable sites; (9) one-stop licensing at the State and Federal level is desirable. The five NRC scenarios were evaluated in terms of regulatory effectiveness.

8423 (PB—269388) **Improving regulatory effectiveness in Federal/State siting actions. Nuclear power plant licensing: A New England perspective. Final report.** Clark, P.B.; Neely, J.H. (Center for Energy Policy, Inc., Boston, Mass. (USA)). Jun 1977. 83p. NTIS PC A05/MF A01.

This study evaluates the nuclear power plant siting licensing process from the New England perspective because the Study Team wanted to consider whether some parts of the licensing process should be conducted on multi-state basis. The report recommends; (1) the establishment of a Lead Agency to coordinate rule making, policy review, and licensing by Federal, State and local governments; (2) site review be conducted separately from the rest of the licensing process and that it be concluded before plant fabrication; (3) the need for power be determined early and based on a generic review of regional demand and supply growth; (4) issues handled generically or in the proposed earlier licensing proceedings be excluded from consideration during GP and OL proceedings; (5) public participation be improved, most particularly by the provision of financial assistance to participants and intervenors; and (6) Federal legislation should be passed to implement the recommendations, but that some changes can be made now, under existing law.

8424 (PB—269389) **Improving regulatory effectiveness in Federal/State siting actions. State and local planning procedures dealing with social and economic impacts from nuclear power plants. Final report.** Curry, M.; Goodreight, J.; Green, M.; Merwin, D.; Smith, R. (Battelle Human Affairs Research Center, Seattle, Wash. (USA)). Jun 1977. 263p. NTIS PC A12/MF A01.

In this report the authors identified and analyzed planning procedures used by state and local governments to cope with the social and economic impacts of nuclear power plant construction. Data were collected on two nuclear power plants in each of three Western states--California, Oregon and Washington. A broad range of social and economic impacts was identified as a framework for the analysis. Then the planning strategies and organizational arrangements used by the state and local governments to plan for and manage impacts were analyzed. The findings include a discussion of the substantive and process-related issues most critical to the effective management of social and economic issues. Substantive issues were those specific impacts identified as most significant, including schools, and public services. Process-related issues included problems in agency coordination, early notification and lead time requirements, management capabilities of local communities and funding.

ECONOMICS

8425 **Effects of the construction of a nuclear power plant on production and employment figures. Results of an input-output analysis.** *DYWIDAG - Ber.;* **43**: No. 26, p. 256-259(Jul 1976). (In German).

Public discussions about the construction of nuclear power plants are mainly held from the point of view of energy supply and environmental protection. This essay is to deal with another aspect, i.e. the effects of the construction of a nuclear power plant for 1,075 million DM (according to the cost situation in 1972) on the production and the number of employees in the industrial branches under certain aspects. This analysis supported by Messes. Kraftwerk-Union AG is based on the input-output calculation of the DIW for 1972. By means of the input-output-calculation it is possible to carry out a quantitative determination also of the indirect dependence of the branches on the construction of a nuclear power plant. Indirectly dependent are branches which do not directly contribute to the construction of a nuclear power plant but have to supply the direct suppliers.

FUEL CYCLE

8426 **International fuel cycle centers offer large economics and easier financing.** Smith, D. *Nucl. Eng. Int.;* **22**: No. 257, 56-59(May 1977).

The summary report of the IAEA study project on multinational regional nuclear fuel cycle indicates that for facilities of reasonable size such projects offer very decisive advantages in fuel cycle costs and resource availability over national facilities in general, and more markedly over the other alternative of the open ended, non-recycle fuel route. The economic evaluation of alternative fuel cycle strategies, one of the basic studies summarised in the report, is considered.

8427 **Will the utilization of nuclear energy from fission reactions be limited by problems of fuel supply.** Collatz, S.; Feigenspan, B.; Rockstroh, R. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). *Energietechnik;* **26**: No. 11, 477-482(Nov 1976). (In German).

Problems of the development of the structure of primary energy sources and of power demand on a world-wide scale are dealt with. Concerning nuclear energy, the development of fast breeder reactors for utilizing natural uranium fuels to a maximum degree is emphasized. Some technical aspects of their realization are discussed.

PROCESS HEAT REACTORS

8428 **Technical scale gas generator for steam gasification of coal using nuclear heat.** Juentgen, H.; Van Heek, K.H. (Bergbau-Forschung GmbH, Essen). *Nucl. Technol.;* **35**: No. 3, 581-590(Oct 1977).

Bergbau-Forschung GmbH has developed a fluidized bed coal gasifier into which the reaction heat is transferred from a gas-cooled high-temperature nuclear reactor (HTR). Extensive material research has shown that new alloys based on Incoloy 800 will meet the specifications required for the heat exchanger. According to bench and pilot plant scale experiments, a technical scale gasifier will process approximately 50 . 10^3 kg of low volatile bituminous coal/h at 40 bar (4 MPa). Such HTR parameters as helium outlet and inlet temperatures, such coal parameters as ash and water content or reactivity, and other parameters exert an impact on operating data of a combined plant consisting of an HTR and a gas plant.

8429 **High-temperature nuclear reactor as heat source for technological processes.** Moscinski, J.; Kwiecinski, S. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). *Zesz. Nauk. Akad. Gorn.-Hutn. Stanisl. Staszica, Mat., Fiz., Chem.;* No. 23, 89-99(1975). (In Polish).

The characteristic features of high-temperature reactors, possibilities and perspectives of their application as sources of heat in technological processes and the actual progress state of investigations on these problems carried on in the world are presented.

NUCLEAR REACTOR TECHNOLOGY

8430 **Secrecy, simultaneous discovery, and the theory of nuclear reactors.** Weart, S. (Director, Center for History of Physics, American Institute of Physics, 335 East 45th Street, New York, New York 10017). *Am. J. Phys.;* **45**: No. 11, 1049-1060(Nov 1977).

The history of nuclear reactors gives us a singular opportunity to study what happens when the world's leading physicists, faced with the same problem, find solutions in complete isolation from one another. This paper takes as an example an elementary part of reactor theory, the four-factor formula. It was discovered independently at least six times (in France, Germany, the Soviet Union, and the United States). But the groups, separated by wartime secrecy, used the formula in very different ways. Usually it was simply ignored. In only two cases was the formula integrated with experimental work: by the French and, in an entirely different way, by Fermi's team in Chicago. Thus even though simultaneous discovery occurred, we need not conclude that the physics developed inevitably in a unique pattern.

8431 **Methods of mathematical modeling and optimization of nuclear power installations.** Popyrin, L.S. *At. Energ. (USSR);* **40**: No. 2, 145-151(Feb 1976). (In Russian).

An analysis is made of the state of art and prospects of developing the method of mathematical modelling in the coordinated optimization of nuclear power plants with the aim of choosing such neutron-physics parameters of reactors, parameters of the thermodynamic cycle and those of the thermal scheme, as well as design and layout characteristics, which would involve minimum estimated costs for each plant. A system is shown of intercommunications of a nuclear power plant which is organized by the principle of hierar-

chy. A mathematical formulation is given of the problem of a coordinated technical and economic design of a nuclear plant of a specified kind, which is a complex problem of nonlinear analoge-to-digital programming. A general order is shown for the automated composition of programmes for the design of thermal power plants. The effect of uncertainty of initial information on posing and solving problems of optimizing nuclear power plants is demonstrated. The positive experience accumulated makes it possible to recommend using the method of mathematical modelling and computers for solving the overwhelming number of this class of problems.

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 9505

8432 (CONF-770902—2) **Statistical algorithm for automated signature analysis of power spectral density data.** Piety, K.R. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 27p. Dep. NTIS, PC A03/MF A01.

From Specialists meeting on reactor noise; Gatlinburg, Tennessee, United States of America (USA) (19 Sep 1977).

A statistical algorithm has been developed and implemented on a minicomputer system for on-line, surveillance applications. Power spectral density (PSD) measurements on process signals are the performance signatures that characterize the "health" of the monitored equipment. Statistical methods provide a quantitative basis for automating the detection of anomalous conditions. The surveillance algorithm has been tested on signals from neutron sensors, proximeter probes, and accelerometers to determine its potential for monitoring nuclear reactors and rotating machinery.

8433 (CONF-770902—3) **Evaluation of the autoregression time-series model for analysis of a noisy signal.** Allen, J.W. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

From Specialists meeting on reactor noise; Gatlinburg, Tennessee, United States of America (USA) (19 Sep 1977).

The autoregression (AR) time-series model of a continuous noisy signal was statistically evaluated to determine quantitatively the uncertainties of the model order, the model parameters, and the model's power spectral density (PSD). The result of such a statistical evaluation enables an experimenter to decide whether an AR model can adequately represent a continuous noisy signal and be consistent with the signal's frequency spectrum, and whether it can be used for on-line monitoring. Although evaluations of other types of signals have been reported in the literature, the author has found no direct reference to AR model's uncertainties for continuous noisy signals; yet the evaluation is necessary to decide the usefulness of AR models of typical reactor signals (e.g., neutron detector output or thermocouple output) and the potential of AR models for on-line monitoring applications. AR and other time-series models for noisy data representation are being investigated by others since such models require fewer parameters than the traditional PSD model (1 to 4). For this study, the AR model was selected for its simplicity and conduciveness to uncertainty analysis, and controlled laboratory bench signals were used for continuous noisy data.

8434 (DP-MS—77-33) **Quantitative consistency testing of thermal benchmark lattice experiments.** Finch, D.R.; Graves, W.E. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 32p. (CONF-771109—26). Dep. NTIS, PC A03/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

The paper sets forth a general method to demonstrate the quantitative consistency (or inconsistency) of results of thermal reactor lattice experiments. The method is of particular importance in selecting standard "benchmark" experiments for comparison testing of lattice analysis codes and neutron cross sections. "Benchmark" thermal lattice experiments are currently selected by consensus, which usually means the experiment is geometrically simple, well-documented, reasonably complete, and qualitatively consistent. A literature search has not revealed any general quantitative test that has been applied to experimental results to demonstrate consistency, although some experiments must have been subjected to some form or other of quantitative test. The consistency method is based on a two-group neutron balance condition that is capable of revealing the quantitative consistency (or inconsistency) of reported thermal benchmark lattice integral parameters. This equation is used in conjunction with a second equation in the following discussion to assess the consistency (or inconsistency) of: (1) several Cross Section Evaluation Working Group (CSEWG) defined thermal benchmark lattices, (2) SRL experiments on the Mark 5R and Mark 15 lattices, and (3) several D_2O lattices encountered as proposed thermal benchmark lattices. Nineteen thermal benchmark lattice experiments were subjected to a quantitative test of consistency between the reported experimental integral parameters. Results of this testing showed only two lattice experiments to be generally useful as "benchmarks," three lattice experiments to be of limited usefulness, three lattice experiments to be potentially useful, and 11 lattice experiments to be not useful. These results are tabulated with the lattices identified.

8435 (EPRI-NP—356(Pt.1)) **Fission product data for thermal reactors. Final report. Part I. A data set for EPRI-CINDER using ENDF/B-IV.** England, T.R.; Wilson, W.B.; Stamatelatos, M.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. 81p. Dep. NTIS, PC A05/MF A01.

A four-group fission-product neutron absorption library, appropriate for use in thermal reactors, is described. All decay parameters are taken from ENDF/B-IV. The absorption cross sections are also processed from ENDF/B-IV files, first into a 154-group set and subsequently collapsed into the 4-group set described in this report. The decay and cross section data were used to form 84 linear chains in the CINDER code format. These chains contain all significant fission products having half-lives exceeding 4 hours—a total of 186 nuclides. A 12-chain set containing one pseudo-chain for use in spatial depletion calculations is described. This set accurately reproduces the aggregate absorption buildup of the 84 chains. This report describes the chains and processed data, results of comparison calculations for various fuels, and a comparison of calculated temporal fission-product absorption buildup with corresponding results from a long-term fuel irradiation and cooling integral experiment.

8436 (EPRI-NP—356(Pt.2)) **Fission product data for thermal reactors. Final report. Part 2. Users manual for EPRI-CINDER code and data.** England, T.R.; Wilson, W.B.; Stamatelatos, M.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. 161p. Dep. NTIS, PC A08/MF A01.

A four-group fission-product absorption chain library using ENDF/B-IV decay data and cross sections processed with a typical light water reactor spectrum for a modified version of the original CINDER code has been developed as described in Part 1. CINDER is a general point-depletion and fission product code based on an analytical solution of the equations describing nuclides coupled in any linear sequence of radioactive decays and neutron absorptions. The basic code has been in wide use for a number of years. Previously, the user was required to specify all physical data. This report describes the chain library in detail and a modified version of the basic CINDER code (EPRI-CINDER) that is still compatible with existing libraries.

8437 (N—77-21938) **Optical line radiation from uranium plasmas.** Maceda, E.L. (Illinois Univ., Urbana (USA)). 1977. 139p. (NASA-CR—152735). NTIS PC A07/MF A01.

The radiative energy current due to line radiation is calculated in a U 235 plasma over a temperature range of 5000 K to 8000 K. Also a variation in the neutron flux of 2 x 10 to the 12th power neutrons/ (sq cm-sec) to 2 x 10 to the 16th power neutrons/(sq cm-sec) is considered. The plasma forms a cylinder with a diameter and height of one meter. To calculate the radiative-energy current, a rate equation formalism is developed to solve for the atomic state densities along with a model for the energy levels in neutral and singly ionized uranium. Because the electron states in uranium lie below 5eV, recombination is the principle excitation mechanism. At and above 6000 K, inversions were found, and at all temperatures the line radiation at line center was greater than the corresponding blackbody radiation. There are negligible differences in the radiative-energy current at 6000 K for variations in the neutron flux. The average opacity, which varied from 100 to 100,000 gm/sq cm, over the frequency range of line radiation is calculated.

8438 **Azimuthal temperature nonuniformity in a regular array of fuel elements for turbulent liquid metal flow.** Ushakov, P.A.; Zhukov, A.V.; Matyukhin, N.M. (Power Engineering Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 64-71(Jul 1977).

Three methods of semiempirical calculation of the temperature nonuniformity in a regular array of fuel elements are considered. An analytical solution is obtained on the hypothesis that the local heat-transfer coefficients are analogous with the heat-transfer coefficients in equivalent plane apertures. Also, a second solution is obtained using the universal temperature profile in a circular tube. In the basic solution considered, the azimuthal spread of heat in the heat carrier is estimated using the temperature profile for rodlike flow. From an analysis of calculated and experimental data, a simple approximate formula for the temperature nonuniformity of the fuel elements is obtained.

8439 **Study of the relative merits of various computational models for evaluation of resonance J(phi, β) function.** Bhaskar Rao, P.; Ganesan, S. (Reactor Research Centre, Kalpakkam (India)). *Atomkernenergie;* **29**: No. 4, 255-258(1977).

The resonance J(phi,β) function has been evaluated and tabulated for a wide range of phi and β values of interest in fast reactor physics calculations with various available computational models with an aim to assess their relative merits. The computational models

investigated for this purpose are those developed by Steen, Sahni and Menon, Hwang, Gelbard, Nicholson and Grasseschi, and that used in the code DOPINT. The degree of sophistication which includes the range of applicability and accuracy and the computing time requirement of each of these computational models has been assessed and reported.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 8540, 8772

8440 (CONF-770807—36) **Plastic instability criteria for necking of bars and ballooning of tubes.** Lin, E.I.H. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

Plastic instability criteria for rate-sensitive materials have been derived in two cases. The first concerns necking in bars under uniaxial tension, and the second ballooning in thin-wall tubes under internal pressure and axial loading. These derivations, primarily based on geometrical considerations, differ in approach from most previous investigations. The results obtained enable explanation of certain interrelationships of uniform elongation, localized deformation, superplasticity, the state of stress and strain, and the material's hardening capability and strain-rate sensitivity.

8441 (EPRI-NP—519) **Evaluation of electromagnetic-acoustic concepts of inspection of steam generator tubing. Final report.** Vasile, C.F.; Thompson, R.B. (Rockwell International Corp., Thousand Oaks, Calif. (USA). Science Center). Aug 1977. 81p. Dep. NTIS, PC A05/MF A01.

The objective of this project was to evaluate the feasibility of using the electromagnetic-acoustic transducer concept for steam generator tube inspection. Results obtained from a laboratory-proof-of-principle demonstration show that this technique is a feasible approach for both steam generator and boiler tube inspections. This report describes the approach and materials used in the experimental work and compares the results with those developed from theoretical considerations. On the basis of this work, a recommendation is made to proceed with development of a prototype system for field evaluation.

8442 (NUREG—0007-2) **Improved ultrasonic nondestructive testing of pressure vessels. Annual progress report, August 1, 1975—July 31, 1976.** Frederick, J.R.; Fairchild, R.C.; Anderson, B.H. (Michigan Univ., Ann Arbor (USA). Dept. of Mechanical Engineering). Jul 1977. vp. NTIS $6.00.

A synthetic aperture focusing technique for ultrasonic testing (SAFT UT) is described. The technique employs a single scanned transducer operating in pulse-echo mode with digital data acquisition and synthetic aperture post-processing to provide high lateral and longitudinal resolution. The extension of previously developed algorithms to provide volumetric processing and display is described. The design of a refreshed grey-scale display to provide interactive display of SAFT UT data is described.

8443 (ORNL—5289) **Simplified analysis methods for high-temperature structural design. Summary of Phase 1 study.** Yahr, G.T. (Oak Ridge National Lab., Tenn. (USA)). 25 Aug 1977. Contract W-7405-ENG-26. 68p. .

Simplified analysis methods for ratchetting and creep-fatigue are provided in ASME Code Case 1592 and RDT Standard F9-5T, but they can only be applied to a limited class of problems. A multiphase analytical investigation was carried out to provide a basis for the application of these methods to a wider range of problems. Predictions by simplified methods were compared with detailed inelastic analysis results for a carefully selected series of problems, including nine two-dimensional axisymmetric cases and two three-dimensional nozzle-to-shell intersection cases. Stresses were produced by cyclic temperatures, internal pressure, and external mechanical loads. Elastic ratchetting and creep-fatigue rules, with a few exceptions, were found to be conservative relative to inelastic analysis predictions. The problems solved and the comparisons made can be used to justify the use of elastic ratchetting and creep-fatigue rules for many situations where they are not currently allowed. Conversely, although one-dimensional cyclic inelastic simulations of the two- and three-dimensional problems give insight into the behavior, a method was not found that would ensure conservative predictions without excessively conservative results in certain instances.

8444 (WARD-SD—3045-6) **User's guide to EURCYL-1: a cylinder—cylinder intersection mesh generator.** Snow, A.L.; Bell, P. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Sep 1977. Contract EY-76-C-02-3045-032. 44p. .

EURCYL is a special purpose finite element mesh generator which creates a model of a cylinder-cylinder intersection. The mesh is created using three-dimensional solid elements. EURCYL was created by EURATOM personnel and may be obtained from the Argonne Code Center. EURCYL-1 designates the version of EURCYL which has been expanded by W-ARD to link with several of the general purpose analysis programs utilized in the USA. EURCYL-1 produces node and element descriptions in a (punched card or data file) format which is compatible with ANSYS, MARC, MAM, and WECAN. The purpose of the report is to describe the use of EURCYL-1 to produce a finite-element model of a cylinder-cylinder intersecion for any one of the above mentioned general purpose thermal-structural computer programs.

8445 **Radiation qualification of nuclear reactor components.** Naber, J.A.; Lurie, N.A. (IRT Corp., San Diego, CA). *Nucl. Technol.;* **36**: No. 1, 40-47(Nov 1977).

Equipment used in nuclear power reactors requires qualification to environments expected under both postulated accident and aging conditions. Proper simulation of the radiation environments requires a knowledge of the reactor radiation fields as well as an understanding of the physical mechanisms of radiation effects, including dose-rate effects, total dose effects, depth-dose effects, heating, induced electrical conductivity, and synergistic effects. In general, radiation qualification programs have not given sufficient attention to the above topics, partly because of the complexity of the problem and partly because of lack of detailed knowledge of the proper conditions to use for testing. A solution to this problem will require a careful characterization of the reactor environments, an identification of the limiting damage mechanisms, and analytical and experimental studies to determine reasonable but meaningful qualification testing procedures.

8446 **Pumping of a liquid metal coolant with the use of accelerating devices on piston-driven gas—liquid flows.** Kolesnichenko, A.F.; Malakhov, V.V.; Gorislavets, Y.M. (Institute of Electrodynamics, Academy of Sciences of the Ukrainian SSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 143-149(Jul 1977).

The thermal schemes of delivery systems for liquid metal coolant circuits in which accelerators of the piston-driven gas—liquid flows are used are analyzed. Individual elements of such devices are examined and experimental data on the effectiveness of their operation are presented.

8447 **Construction and characteristics of transducers for measurements in in-pile test sections.** Angelino, G.; Riva, B.; Ugge, A. *Energ. Nucl. (Milan);* **22**: No. 12, 630-641(Dec 1975). (In Italian).

Transducers for the in-pile measurement of displacement, vibration, strain, temp. and neutron flux are described. 7 references.

FUEL ELEMENTS

8448 (CONF-770807—42) **Structural analysis of reactor fuel elements.** Weeks, R.W. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A03/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

An overview of fuel-element modeling is presented that traces the development of codes for the prediction of light-water-reactor and fast-breeder-reactor fuel-element performance. It is concluded that although the mathematical analysis is now far advanced, the development and incorporation of mechanistic constitutive equations has not kept pace. The resultant reliance on empirical correlations severely limits the physical insight that can be gained from code extrapolations. Current efforts include modeling of alternate fuel systems, analysis of local fuel-cladding interactions, and development of a predictive capability for off-normal behavior. Future work should help remedy the current constitutive deficiencies and should include the development of deterministic failure criteria for use in design.

CONTROL SYSTEMS

REFER ALSO TO CITATION(S) 8498

8449 (CEN—50(Rev.1)) **C-E burnable poison irradiation test program.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Aug 1977. 53p. Engineering, Inc., Windsor, CT.

The burnable poison material employed by C-E consists of B_4C particles distributed in an Al_2O_3 matrix in concentrations up to 4 weight percent. Over the past four years, the performance of Zircaloy clad burnable poison rods has been examined as part of fuel inspection programs conducted during refueling outages at several C-E PWRs.

8450 (CONF-770939—2) **Plant control system design for the Clinch River Breeder Reactor Plant.** DeMore, L.A.; Bapna, B.H.; Matta, J.V. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1977. Contract EY-76-C-15-2395. 22p. Dep. NTIS, PC A02/MF A01.

From 3. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (7 Sep 1977).

The design of the plant control system for the CRBR is described. The description covers both the process servos and the supervisory control system.

8451 (MRR—155) **Parameter identification of a BWR nuclear power plant model for use in optimal control.** Volf, K. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Reaktordynamik und Reaktorsicherheit). Feb 1976. 106p. Dep. NTIS (US Sales Only), PC A06/MF A01.

The problem being considered is the modeling of a nuclear power plant for the development of an optimal control system of the plant. Current system identification concepts, combining input/output information with a-priori structural information are employed. Two of the known parameter identification methods i.e., a least squares method and a maximum likelihood technique, are studied as ways of parameter identification from measurement data. A low order state variable stochastic model of a BWR nuclear power plant is presented as an application of this approach. The model consists of a deterministic and a noise part. The deterministic part is formed by simplified modeling of the major plant dynamic phenomena. The moise part models the effects of input random disturbances to the deterministic part and additive measurement noise. Most of the model parameters are assumed to be initially unknown. They are identified using measurement data records. A detailed high order digital computer simulation is used to simulate plant dynamic behaviour since it is not conceivable for experimentation of this kind to be performed on the real nuclear power plant. The identification task consists in adapting the performance of the simple model to the data acquired from this plant simulation ensuring the applicability of the techniques to measurement data acquired directly from the plant.

8452 **Nuclear reactor control system design with sensor failure.** Miller, L.F. (Univ. of Tennessee, Knoxville); Cochran, R.G.; Howze, J.W. *Nucl. Technol.;* **36**: No. 1, 93-105(Nov 1977).

The problem of designing a constrained feedback control system for a nuclear reactor is investigated. The constraint imposed is that system stability must be retained under possible loss of any arbitrary feedback signal due to failure of the signal sensor. In addition, the control law is synthesized using only partial state availability, and the nominal control system without sensor failure is designed so that the system performs in a desired fashion. Several mathematical models of the reactor dynamics were employed. However, only a model with negative moderator activity coefficients and a single delayed neutron group was used as an example. This model permits a demonstration of two different computational methods for obtaining the required feedback control laws. The first of these two computational methods uses a global procedure for solving polynomial inequalities that represent the stabilization problem. The second method uses an algorithm for decreasing a spectral radius function until it is negative, thus allowing implicit control over eigenvalue placement.

8453 **SOPHT: a computer model for CANDU-PHWR heat transport works and their control.** Chang, C.Y.F.; Skears, J. (Ontario Hydro, Toronto). *Nucl. Technol.;* **35**: No. 3, 591-602(Oct 1977).

A digital computer simulation program, SOPHT, was developed by the Nuclear Generation Division of Ontario Hydro to assist their operating staff to ensure safe, reliable, and economic power generation. The program is used to predict the transient performance for Canadian deuterium uranium pressurized heavy water reactor (CANDU-PHWR) heat transport and steam supply networks together with their associated control systems. The model was verified by test data obtained in an operating plant. Examples are used to review and demonstrate the applications and contributions of this simulation program to plant operations.

8454 **Spatial reactor control methods.** Karppinen, J. (OECD Halden Reactor Project, Halden, Norway). *Nucl. Sci. Eng.;* **64**: No. 2, 657-672(Oct 1977).

A review of spatial reactor control methods that have employed optimization techniques is presented. Automatic spatial control systems are briefly outlined, the formulation of the spatial control problem as an optimal control problem is discussed, and solution methods based on distributed parameter optimal control, variational calculus, dynamic programming, mathematical programming, the maximum principle, linear-quadratic control theory, and heuristic control techniques are reviewed.

8455 **Identification of nuclear plant parameters using experimental data and high-order dynamic models.** Chang, S.I. (Inst. of Nuclear Energy Research, Lungtan, Taiwan); Kerlin, T.W. *Nucl. Sci. Eng.;* **64**: No. 2, 673-683(Oct 1977).

Large linear dynamic models for nuclear reactor systems are widely used for simulation and control system design. It is important to be able to verify these models and the parameters in them. Existing parameter identification techniques are very time consuming for use with large systems. Identification is achieved by an optimization procedure that adjusts system parameters to minimize differences between experimental frequency responses and theoretical frequency responses obtained from the dynamic model. A new method that uses a partitioned matrix technique was developed. This technique constitutes a very efficient analysis algorithm for large models when implemented on the digital computer. The work included a study of methods for assessing the identifiability of parameters by fitting dynamic test data. The Fisher information matrix was found to be useful for this purpose. It was also found that the frequency dependency of the sensitivity function is important in determining identifiability. The measurements should include frequencies where the sensitivity to the parameter of interest is largest. Also, it was found that separate, unique identification of parameters with parallel curves of sensitivity versus frequency is impossible regardless of how large the magnitudes of the sensitivities are. The method was demonstrated in a test case. It used data (from the Oconee I pressurized waterreactor) and a 29th-order model. The results demonstrated that the computational requirements are reasonable for large systems and that the procedure can identify parameters if all the necessary conditions are satisfied. In general, the work has provided a systematic method for parameter identification in systems described by large linear dynamic models.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 8278, 9017, 9035

RADIOACTIVE EFFLUENTS

8456 (WaBoLu—16/74) **Routine method to determine radionuclides in the emissions from nuclear power plants.** Wolter, R.; Arndt, J. (Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene). Sep 1974. 21p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

When planning nuclear power stations, especially during site selection, the degree to which the environment would be endangered by the emission of radioactive substances should be taken into account. This requires radioecological analyses for every protected site. In these analyses, the conventional procedures for the detection of radioactive emissions, which only provided for the determination of the total activity, were not sufficient for an assessment of the possible effects of such emissions. Therefore, a new procedure for the detection of radioactive emissions was attempted by which the types and amounts of individual radionuclides may be determined. Owing to the cooperation of all nuclear power plant operators in the Federal Republic of Germany, a procedure could be developed with which we could monitor and analyze all radioactive waste water emissions since 1972.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 8391, 8479, 8489, 8501, 8512, 8525

8457 (CONF-770807—35) **Subassembly bowing experience in EBR-II.** Bottcher, J.H.; Hofman, G.L. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

In-reactor bowing of subassemblies has caused some handling difficulties at EBR-II, the extent of the problem increasing with the subassembly stiffness. Analysis of four particular bowed subassemblies with respect to their core environment and structural design has indicated that residual bow is primarily the result of radiation-enhanced creep during irradiation.

8458 (CONF-770807—39) **Parametric investigation of fracture of EBR-II ducts.** Chopra, P.S.; Moustakakis, B. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 23p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

Results of preliminary static and dynamic finite element fracture mechanics analyses that were conducted to analytically simulate

the dynamic fracture behavior of EBR-II ducts are presented. The loads considered are those that may arise because of rapid release of fission gases from a failed fuel element inside a duct, obtained from some previous tests and a recent analytical model. In spite of the motivation for the present work, the analytical procedures described may have a wider general application in the fail-safe design of structures.

8459 (CONF-770807—43) **Mechanical response of FFTF reference and P1 cladding tubes under transient heating.** Youngahl, C.A.; Ariman, T.; Lepacek, B.E. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

Burst tests of Type 316 stainless steel cladding tube samples subjected to increasing temperature and relatively constant internal pressure were conducted to assist in the pretest analysis of the P1 experiment performed in the Sodium Loop Safety Facility. This paper reports and analyzes the burst test results and those of subsequent transient heating work. The use of a modified extensometer in obtaining mechanical response data for stainless steel in the high temperature range is illustrated, some of such data is provided, and the potential of further experiments and analysis is indicated. Tubing of the same design as Fast Flux Test Facility (FFTF) cladding (20% cold worked, 0.230 in. OD, 15 mil wall) was tested as-received and after annealing or electrolytic thinning. P1 tubing (38% cold worked, 0.230 in. OD, 10 mil wall) was tested before and after aging under conditions anticipated in the P1 reactor experiment. The P1 cladding was designed to simulate FFTF tubing that had experienced irradiation embrittlement and attack by cesium oxide and sodium impurities.

8460 (CONF-770807—44) **Proof tests of irradiated and unirradiated EBR-II subassembly ducts.** Ruther, W.E.; Chopra, P.S.; Lambert, J.D.B. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

A series of dynamic pressure tests have been conducted within EBR-II subassembly ducts. The tests were designed to simulate bursting of a driver-fuel element in a cluster of such elements at their burnup limit during off-normal conditions in EBR-II. The major objective of the tests was to assure that such failure, which might cause rapid release of stored fission gas, would not deform or otherwise damage subassembly ducts in a way that would hinder movement of a control rod. The test results are described.

8461 (CONF-770822—6) **ERB-II operating experience.** Smith, R.N.; Cissel, D.W.; Smith, R.R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 52p. Dep. NTIS, PC A04/MF A01.

From American Nuclear Society meeting; Chattanooga, Tennessee, USA (8 Aug 1977).

As originally designed and operated, EBR-II successfully demonstrated the concept of a sodium-cooled fast breeder power plant with a closed fuel reprocessing cycle (mini-nuclear park). Subsequent operation has been as an irradiation facility, a role which will continue into the foreseeable future. Since the beginning of operation in 1961, operating experience of EBR-II has been very satisfactory. Most of the components and systems have performed well. In particular, the mechanical performance of heat-removal systems has been excellent. A review of the operating experience reveals that all the original design objectives have been successfully demonstrated. To date, no failures or incidents resulting in serious in-core or out-of-core consequences have occurred. No water-to-sodium leaks have been detected over the life of the plant. At the present time, the facility is operating very well and continuously except for short shutdowns required by maintenance, refueling, modification, and minor repair. A plant factor of 76.9% was achieved for the calendar year 1976.

8462 (CONF-771036—3) **Dosimetry experiment for neutron spectral characterization of the second NRC 4T-CT irradiation capsules at BSR.** Kam, F.B.K.; Swanks, J.H.; Stallmann, F.W. (Oak Ridge National Lab., Tenn. (USA); Tennessee Univ., Knoxville (USA)). 1977. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

From 2. ASTM-EURATOM symposium on reactor dosimetry) dosimetry methods for fuels, cladding and structural materials; Palo Alto, California, USA (2 Oct 1977).

In support of the Nuclear Regulatory Commission (NRC) Heavy Section Steel Technology (HSST) irradiation experiment in progress at the Bulk Shielding Reactor (BSR), a multiple foil dosimetry test has been performed to obtain neutron spectral information at key locations within three simulated HSST capsules. A combination of reactor physics calculations with unfolding and linear programming procedures was used for the evaluation and validation of the results. Certain spectral parameters in the fast neutron spectrum-above 1 MeV-can be determined with accuracies of 10 to 20%. Further tests show good agreement between the neutron flux distribution in this experiment and the one containing the mechanical test specimen.

8463 (GSF-P—117) **Annual report 1976.** (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (Germany, F.R.). Physikalisch-Technische Abt.). 1976. 91p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

After a general survey on the operation team 'research reactor Neuherberg', the author reports on the routine operation, experiments, and experimental devices and on work in the field of tracer analysis in several medical-biological fields.

8464 (HEDL-SA—1154) **Gas tagging for fuel failure location using xenon and krypton.** Goheen, M.W.; Plucinski, C.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1977. Contract EY-76-C-14-2170. 14p. (CONF-770687—1). Dep. NTIS, PC A02/MF A01.

From The American Society of Mass Spectrometry; Washington, District of Columbia, USA (2 Jun 1977).

The FFTF (Fast Flux Test Facility) nearing completion at the Hanford Engineering Development Laboratory near Richland, Washington, under the direction of The Westinghouse Hanford Co., is designed to test components and materials for the development of Liquid Metal Fast Breeder Reactors. During the initial stages of operation, the FFTF will be shut down when a fuel or control pin has a detectable cladding leak. To achieve maximum reactor operating time, monitoring methods for detecting and locating leaking pins were developed. Monitoring techniques to signal a leak are based on changes of specific activity levels of individual xenon and krypton fission product isotopes. Gas tagging is the method used to locate the failed pin. Isotopically differing tags of a gas or gases can be used as a fingerprint technique for sealed assemblies such as fuel or control pins with mass spectrometer detection to locate a specific leaker. 104 unique tags were blended for the 80 fuel assemblies and 24 control assemblies.

8465 (HEDL-SA—1286) **Cladding development and characterization in the United States.** Lobsinger, R.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1977. Contract EY-76-C-14-2170. 27p. (CONF-770694—1). Dep. NTIS, PC A03/MF A01.

From U.S. Japan exchange meeting; Sunnyvale, California, USA (27 Jun 1977).

During the past decade, an extensive program of cladding development has been carried out at HEDL in support of the FFTF/Breeder Reactor Program. This activity has resulted in the establishment of specification, fabrication, and characterization requirements for breeder reactor fuel cladding. In establishing these requirements, input has been derived from vendor development programs, evaluation studies, and reviews with other national laboratories. The major fabrication requirements of the current specification as derived from the development program and the testing required to assure product conformance and characterize cladding behavior are described.

8466 (HEDL-TME—76-10) **Activated corrosion product radiation levels in the FFTF heat transport system cells and closed loop system modules.** Kuhn, W.L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-14-2170. 115p. .

Radiation levels due to activated corrosion products in an FFTF Heat Transport System (HTS) cell and in a Closed Loop System (CLS) module are estimated for various maintenance locations. ^{54}Mn is found to be the dominant radionuclide. While control of ^{54}Mn release or transport would substantially reduce radiation levels, ^{54}Mn, ^{60}Co, and ^{58}Co must all be controlled to permit unshielded maintenance for the FFTF rated operating condition. Radiation levels are found to be relatively insensitive to sodium oxygen concentration but very sensitive to operating temperature. The average radiation level in an HTS cell is predicted to rapidly exceed 0.2 R/hr and eventually reach 4 R/hr at the FFTF rated core outlet temperature of 1100°F. At the 980°F, 0.7 R/hr is interpolated. The predicted radiation levels would preclude unshielded maintenance operations in an HTS cell. Radiation levels near a CLS module are predicted 0.2 to 2 R/hr, depending on the assumed operating temperature.

8467 (HEDL-TME—76-47) **FFTF development testing. Technical progress report, July—September 1976.** Bliss, R.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1976. Contract EY-76-C-14-2170. 32p. .

Progress is summarized in the following areas: (1) refueling and plant equipment testing, (2) mechanical equipment testing, and (3) control and data systems. (DG)

8468 (HEDL-TME—77-44) **High ^{240}Pu FTR/EMC experiments and analysis: Carbide fuel and UO_2 blanket subassembly worths.** Ombrellaro, P.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-14-2170. 40p. Dep. NTIS, PC A03/MF A01.

Carbide-plutonium fuel and UO_2 blanket subassembly worth measurements performed at ANL in the EMC/LWR were analyzed. Composition exchange worth calculations were performed for: (a) the replacement of high-^{240}Pu fuel composition for low-^{240}Pu fuel composition and carbide-plutonium fuel composition, successively, in the center subassembly of the core; (b) the replacement of low-^{240}Pu fuel composition for carbide—plutonium fuel composition in one outer driver subassembly; and (c) the replacement of the radial reflector composition with UO_2 blanket composition in one subassembly of the radial reflector. The composition exchange worth calculations were performed in two-dimensional x,y geometry, using diffusion theory and perturbation theory. Each method produces about the same calculated-to-experimental bias factors.

8469 (ITEF—96) **Reactivity changes due to small accidental displacements of fuel rods in a heterogeneous reactor.** Galanin, A.D.; Kochurov, B.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1975. 19p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The change of reactivity due to small accidental displacements of fuel rods is investigated for a heterogeneous reactor having a uniform lattice of elements. The reactivity loss is shown to be usually not large for instance, delta $K/K = 10^{-4}$ for a heavy water assembly with natural uranium fuel rods of radius rho = 1.4 sm, arranged is a lattice with a pitch of 10 sm, if mean square displacements are equal to 0.4 sm. The estimates are important for assemblies designed to carry out precise integral experiments.

8470 (ORNL/TM—6033) **Bulk Shielding Facility quarterly report, January, February, and March of 1977.** Hurt, S.S. III; Lance, E.D.; Thomas, J.R. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

The BSR operated at an average power level of 1,975 kw for 75.47% of the time during January, February, and March. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The BSR was operated at low and variable power during this quarter for 45.567 hours as part of the training programs for nuclear reactor operator trainees from Memphis State University. The PCA was also used in training programs and was operated on thirty-three occasions when Memphis State University, the University of Tennessee, Louisiana State University, the University of Oklahoma, or Mississippi State University students actively participated in training laboratories.

8471 (SAND—77-1015C) **In-core fuel motion detection in the Sandia Pulse Reactor.** Wright, S.A.; Renken, J.H.; Kroeger, F.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 6p. (CONF-771109—5). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

One of the major fuel motion diagnostic techniques under consideration for use in large scale fast reactor safety tests is in-core fuel motion detection. The Nuclear Regulatory Commission is funding a program at Sandia Laboratories to experimentally test the feasibility of using in-core neutron detectors to monitor fuel motion in medium- to large-scale tests. The new areas of research required by this program are the development of miniature neutron detectors which can be placed in hollow wire wrap and the development of unfolding methods which relate detector response to fuel motion.

8472 (SAND—77-1019C) **Design of LMFBR safety test reactors.** Ostensen, R.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 5p. (CONF-771109—10). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

One part of the LMFBR safety assurance program has been the testing to failure of prototypic fuel in a sodium environment. Effort has recently been applied toward development of a new Safety Test Facility (STF) which would provide improved testing capability. Alternative test reactor design work has been done on the Phoebus/Uhtrex design and the High Fluence Fast Pulse Reactor (HFFPR). As part of the HFFPR design effort, a criterion has been developed to allow rapid and inexpensive scoping analyses of different core designs, using zero-dimensional neutronics calculations. This paper derives this criterion and describes several promising core designs which were explored with this method.

8473 (SAND—77-1080C) **Calculated physics and performance parameters for the ACPR upgrade.** Pickard, P.S.; Odom, J.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 10p. (CONF-771109—17). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

Reactor physics and core design calculations have been completed for the upgrade of the Annular Core Pulse Reactor (ACPR) at Sandia Laboratories. The ACPR has been in operation since 1967 and is a U-Zr H/sub 1.6/ fueled swimming pool type reactor with a large dry central experiment cavity. The purpose of the upgrade of the ACPR is to provide improved pulse and steady-state capabilities for performing neutron simulation and reactor safety tests. The performance goals for the ACPR Upgrade were to achieve a factor of 2.6 times the pulse fluence available with the ACPR and a factor of 2 increase in the steady-state flux. In addition, the pulse width of the upgraded reactor was to be as short as practical to maintain the rapid transient simulation capability of the ACPR.

8474 (SAND—77-1133) **Annular Core Pulse Reactor Upgrade. Quarterly report, April—June 1977.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 35p. (NUREG—0120-3). Dep. NTIS, PC A03/MF A01.

The object of the ACPR upgrade is to arrive at a reactor modification which will provide an increased pulsed neutron fluence in the irradiation cavity without an excessive degradation of the pulse duration. The upgraded reactor will also have an increased steady-state neutron flux. The initial approach to the upgrade modification involved a two-region core concept. Progress is reported for the following tasks: (1) safety, documentation, and compliance; (2) core nuclear design; (3) console development; (4) mechanical design; (5) fuel element design; (6) BeO—UO_2 fuel element fabrication; (7) secondary fuel material studies; (8) driver core fuel element; and (9) diagnostic system.

8475 **Approximate simple formula for the shielding effect of the cadmium jacket designed for the use of fast neutrons among reactor neutrons.** Okada, M.; Arigane, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Radioanal. Chem.;* **36**: No. 1, 239-245(1977).

If a pneumatic tube in an experimental hole of a reactor is covered with a cadmium jacket, a sample inserted in the pneumatic tube will be exposed to not only fast and epithermal neutrons but also the few thermal neutrons that will not have been obstructed by the jacket. To obtain a simple method of estimation for the flux of these thermal neutrons, a formula has been made. The ratio of change in thermal-neutron flux due to the setting of the jacket has been expressed as a function of 5 dimensionless numbers. The formula enables one to design a wellproportioned jacket.

8476 **Case history of fabricating numerical-controlled machinery for the nuclear industry.** Lewis, J.F. Dearborn, MI; Society of Manufacturing Engineers (1975). 15p.

Working to tight tolerances, attaining specific mechanical properties and conforming to rigid specifications are some of the problems that occur in fabricating machinery for the nuclear industry. The equipment being built is the In-Vessel Handling Machine, which is to be used in the Fast Flux Test Facility. The largest fabrication for the machine is the Reactor Refueling Plug (RRP). The body of the RRP is a low-alloy steel forging (ASME SA508) that is 24 in. thick and 72 in. in dia. It is clad with a Ni-base alloy (AWS ERNiCr-3) wherever an attachment is welded on. All of the attachments are 304 series stainless steel except for an Inconel 600 attachment which forms a skirt around the bottom of the plug. The manufacturing sequence for the RRP called for the welding to be accomplished in three phases.

REACTOR SAFETY

8477 (AED-Conf—76-660-021) **Safety strategy and safety analysis of nuclear power plants.** Franzen, L.F. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). 1976. 26p. (CONF-7609150—32). Dep. NTIS (US Sales Only), PC A03/MF A01.

From IAEA international training course on nuclear power project planning and implementation; Karlsruhe, F.R. Germany (6 Sep 1976).

The safety strategy for nuclear power plants is characterized by the fact that the high level of safety was attained not as a result of experience, but on the basis of preventive accident analyses and the finding derived from such analyses. Although, in these accident analyses, the deterministic approach is predominant, it is supplemented by reliability analyses. The accidents analyzed in nuclear licensing procedures cover a wide spectrum from minor incidents to the design basis accidents which determine the design of the safety devices. The initial and boundary conditions, which are essential for accident analyses, and the determination of the loads occurring in various states during regular operation and in accidents flow into the design of the individual systems and components. The inevitable residual risk and its origins are discussed.

8478 (AI/FBR—77-1) **PLBR core selection for low CDA energetics: Liquid Metal Fast Breeder Reactor design project.** (Atomics International Div., Canoga Park, Calif. (USA)). 1 Feb 1977. Contract EY-76-C-03-1142. 306p. .

A study made to determine the feasibility of providing a PLBR core which has inherently nonenergetic CDA characteristics is presented. If such a core can be provided, it is expected that containment of large CDA energetics would not be required for licensing. The five major stages of this effort were: (1) Establishment of design requirements and configuration selection criteria; (2) Performance of extensive nuclear design and reactor system-related safety parametric studies, to provide a basis for choosing designs (i.e., bullseye and spoiled regular configurations) representative of the basic "nonenergetic" core concepts; (3) Selection and detailed characterization of the reference bullseye and spoiled regular core configurations; (4) Comparison of the reference designs against the selection criteria; and (5) Selection of the core configuration to be recommended for PLBR. Also included in the study was the determination of characteristics of a regular core. This provided a baseline against which to compare the performance and safety features of the candidate low-energy cores. Details of the approach followed, and results obtained, are presented.

8479 (ANL—77-40) **Summary and evaluation of transient test data on extended fuel motion resulting from unprotected loss of flow.** Dickerman, C.E. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 38p. Dep. NTIS, PC A03/MF A01.

Experimental data on fuel failure and its consequences are used to provide predictions of the extended fuel motion that would occur after a hypothetical core-disruptive loss-of-flow accident without scram in the Fast Test Reactor. These data indicate the existence of fuel-dispersal mechanisms, slow collapse of fresh fuel, resistance to collapse of irradiated fuel, the absence of accelerated collapse mechanisms (such as cladding-coolant vapor "explosions"), and the fact that real LMFBR conditions inhibit rapid sodium-vaporization events. These data indicate that severely damaged subassemblies will not be coolable in situ by returning sodium after the accident, because of steel and fuel blockages, and suggest that the severely damaged, melted fuel will eventually disperse upward under the influence of vapor generated by decay heating.

8480 (ANL—77-59) **Light-water-reactor safety program. Quarterly progress report, April—June 1977.** Sachs, R.G.; Kyger, J.A. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 145p. Dep. NTIS, PC A07/MF A01.

The report summarizes work performed on the following water-reactor-safety problems: (1) loss-of-coolant accident research in heat transfer and fluid dynamics; (2) transient fuel response and fission-product release; (3) mechanical properties of zircaloy containing oxygen; and (4) steam-explosion studies.

8481 (ANL-CT—77-31) **Thermal buoyancy phenomena in a horizontal pipe during a flow coast-down thermal-hydraulic transient (scoping studies).** Kasza, K.E.; Schmitt, R.C.; Sha, W.T. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 32p. .

Initial problem scoping studies on thermal stratification effects in horizontal LMFBR piping during a pump coast-down cooling transient have been performed using the ANL COMMIX computer code. It is found that thermal buoyancy forces can create appreciable secondary flow and thermal effects. For the problem studied, donut shaped flow patterns develop in the pipe circular cross sections symmetrically on both sides of the pipe vertical symmetry plane; the patterns, for the case of a pipe inlet cooling transient, are produced by the sinking to the bottom of the pipe of the cooler fluid entering the pipe. In addition, a large longitudinal recirculation loop is established which convects warmer downstream fluid upstream in the pipe and greatly increases the pipe top-bottom temperature difference as well as causing the thermal-stratification-effects front to move faster through the pipe than would be indicated by the pipe inlet mean velocity. A pipe top-bottom stratification temperature difference in excess of 100°F (55.6°C) occurred which amounted to nearly 60% of the pipe-inlet-flow-transient temperature decline. This result contradicts the usual isothermal-front assumption employed in LMFBR system analysis codes. In general results are obtained which suggest that additional studies (both experimental and analytical) be undertaken to obtain information which can be directly applied to both design of LMFBR piping and assessment of thermal stratification effects under conditions of pump coast-down and natural circulation. Recommendations are also made as to the directions and focus of further research efforts.

8482 (BMI-NUREG—1981) **Fission product transport analysis: Task 2. Quarterly progress report, April—June 1977.** Gieseke, J.A.; Jordan, H.; Baybutt, P.; Wooton, R.O.; Denning, R.S. (Battelle Columbus Labs., Ohio (USA)). 30 Sep 1977. 17p. NTIS $4.00.

Continuing activities associated with modeling the transport and deposition of fission products within PWR and BWR primary systems during the reflood time period following a terminated LOCA are reported. The original scope of the overall project has been expanded to include consideration of conditions consistent with those leading to postulated core meltdown situations. Initial tasks on this continuation study involve limited improvements to the TRAP codes and performance of sensitivity analyses for terminated LOCA's plus the evaluation of thermal-hydraulic conditions for use in evaluating fission product transport and deposition in postulated meltdown situations. Beyond these initial tasks, emphasis will be concentrated solely on meltdown analyses. Major efforts within the past quarter have included completion in final form of the informal interim report on analyses for terminated LOCA conditions, initiation of improvement for the TRAP codes to include additional fission product deposition mechanisms, consideration of suitable methods for performing the sensitivity analyses, specification of ranges for variables to be covered in the sensitivity analyses, and initiation of efforts to specify flow conditions to be assumed in future development of analysis procedures applicable to meltdown conditions.

8483 (BNL—23196) **Higher order effects and their influence on the HTGR core.** Curreri, J.; Bezler, P.; Koplik, B.; Reich, M.; Subudhi, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 12p. (CONF-770929—8). Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, New York, USA (15 Sep 1977).

An HTGR core responds nonlinearly to an earthquake input. Nonlinear systems are different from linear systems. Academically, there is no characteristic natural frequency in the no linear vibratory system. Instead, there are resonant peaks that can develop. These are related to the amplitude and frequency of the forcing function as well as to the system characteristics and the transients that exist at the time. In particular, the frequency of peak response is strongly affected by the magnitude of the input amplitude. As in linear systems, resonance can be produced when the forcing frequency is equal to or less than the natural frequency. In addition, in a nonlinear system only, resonances can be produced when the forcing frequency is above the "natural" frequency. When this occurs, the resonance is referred to as a subharmonic resonance, that is, the frequency is 1/n times the forcing frequency. The occurrence of subharmonic resonance in a series of blocks with clearance between blocks and with springs on the outermost ends is the subject of the paper. The response of an idealized nonlinear one degree of freedom system to two sine waves is discussed. The influence of the elastic characteristics and damping is also examined.

8484 (BNL-NUREG—22734) **Analyses and computer code developments for accident-induced thermohydraulic transients in water-cooled nuclear reactor systems.** Wulff, W. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 53p. (CONF-771120—10). Dep. NTIS, PC A04/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, Georgia, USA (27 Nov 1977).

A review is presented on the development of analyses and computer codes for the prediction of thermohydraulic transients in nuclear reactor systems. Models for the dynamics of two-phase mixtures are summarized. Principles of process, reactor component and reactor system modeling are presented, as well as the verification of these models by comparing predicted results with experimental data. Codes of major importance are described, which have recently been developed or are presently under development. The characteristics of these codes are presented in terms of governing equations, solution techniques and code structure. Current efforts and problems of code verification are discussed. A summary is presented of advances which are necessary for reducing the conservatism currently implied in reactor hydraulics codes for safety assessment.

8485 (BNL-NUREG—22860) **Analysis of gas circulation in an HTGR containment.** Omata, I.; Takahashi, H. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 7p. (CONF-771109—25). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

Circulation and primary gas concentration in an HTGR containment during a PCRV depressurization accident have been studied to analyze layering and complete mixing models. If layering occurs, the problem of potential buildup or local concentration of combustible gas becomes important. The study was performed for a typical 3000 MW(t) system assuming that the clean-up system failed. Because of the difficulty and complexity in calculation, no obstacles were considered. The CIRC code was developed for this analysis because it offers advantages over other codes such as SOLA or KACHINA for easier application to HTGRs. While the typical HTGR containment has a semi-spherical dome, CIRC is limited to rectangular geometry in x-y and cylindrical dimensions, and to simulate three-dimensional phenomena, several cases were calculated.

8486 (BNL-NUREG—50603) **Post-accident fuel relocation and heat removal in the LMFBR.** Kazimi, M.S.; Tsai, S.S.; Gasser, R.D. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1976. Contract EY-76-C-02-0016. 116p. Dep. NTIS, PC A06/MF A01.

Assessment of the dynamics of post-accident fuel relocation and heat removal is an important aspect of the evaluation of the consequences of a hypothetical accident in an LMFBR. Such an assessment is of particular importance in the evaluation of the post-accident radiological doses around the reactor site. In the present evaluation particular attention is given to the design features of the Clinch River Breeder Reactor Plant (CRBR). Fuel relocation and heat removal, assuming certain conditions have resulted in core disruption, are discussed. The discussion of events and phenomena involved in the relocation processes is centered around the resulting patterns of heat source distribution. The factors influencing fuel relocation and distribution in the inlet and outlet plena of the reactor vessel are discussed. The current technology of in-vessel heat removal is applied to the design of the CRBR reactor. Both fuel debris cooling limits and overall coolant flow in the reactor under natural convection conditions are explored. Some of the uncertainties in ex-vessel fuel behavior are addressed. In particular, the effect of melting the cavity bed on the rate of growth of a molten fuel pool is investigated.

8487 (CONF-770708—16) **High-temperature deformation and rupture behavior of internally-pressurized Zircaloy-4 cladding in vacuum and steam enivronments.** Chung, H.M.; Garde, A.M.; Kassner, T.F. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A03/MF A01.

From Thermal reactor safety meeting; Sun Valley, Idaho, United States of America (USA) (31 Jul 1977).

The high-temperature diametral expansion and rupture behavior of Zircaloy-4 fuel-cladding tubes have been investigated in vacuum and steam environments under transient-heating conditions that are of interest in hypothetical loss-of-coolant accident situations in light-water reactors. The effects of internal pressure, heating rate, axial constraint, and localized temperature nonuniformities in the cladding on the maximum circumferential strain have been determined for burst temperatures between approximately 650 and 1350°C.

8488 (CONF-770807—39) **Effect of high external thermal loading on LMFBR subassembly integrity.** Smith, J.L.; Helenberg, H.W.; Kilsdonk, D.J.; Pedersen, D.R.; Pierce, R.D.; Wilson, R.E.; Ariman, T. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

One of the postulated accidents to be considered in the evaluation of the safety and integrity of a Liquid Metal Fast Breeder Reactor (LMFBR) is a complete meltdown (loss-of-cooling) of a subassembly without reactor shutdown. One barrier to further propagation is the ducts of the adjacent subassemblies. The meltdown of a subassembly can result in a pressure loading and/or a thermal loading of the adjacent subassembly ducts. There are four potential failure modes of the adjacent duct: (1) failure as a result of coolant boiling inside the adjacent duct followed by melting of the duct, (2) cracking of the duct as a result of thermal stress, (3) deformation of the duct as a result of thermal stress followed by coolant boiling and melt through, and (4) weakening of the duct as a result of high temperature allowing pressure loading to cause duct failure. The purpose of this paper is to discuss the experimental investigation of the thermal loading of the adjacent subassembly ducts as a result of application of fuel to one flat.

8489 (CONF-770807—40) **Thermal and stress analyses of meltdown cups for LMFBR safety experiments using SLSF in-reactor loops.** Blomquist, C.A.; Ariman, T.; Pierce, R.D.; Pedersen, D.R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 21p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

A description of a meltdown cup to be used in the SLSF in-reactor experiments is presented. Thermal analyses have shown that the cup is capable of containing and cooling the postulated quantities of molten fuel and steel. The basic loadings for stress analyses were defined and failure modes were determined. It was shown that both the maximum bending stress and maximum tangential stress in the Inconel vessel are below the material yield stress. Additionally, the axial stress in the Inconel vessel was found to be negligible. The shear stress in the wire-formed retaining ring is much below the maximum shear stress. Therefore, the meltdown cup is capable of performing its required function.

8490 (CONF-770807—49) **Extension of HCDA safety analysis to large PCRV containment structures.** Marchertas, A.H.; Fistedis, S.H.; Bazant, A.P.; Belytschko, T. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 29p. Dep. NTIS, PC A03/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, United States of America (USA) (15 Aug 1977).

The introduction of PCRV as part of LMFBR containment also brings in the need for dynamic analysis. The conventional design would not be adequate for designing PCRVs subject to highly transient loading. The PCRV models described provide a valuable illustration of the design arrived at by conventional means and loaded dynamically by means of the transient computer code. In particular the value of the computer code is realized in the case of the loop-type model. The original pressure-volume source used for the illustrative examples corresponds to a total available energy of 2720 MW-s, if the expansion were continued down to one bar. Thus the energy source is considerably larger than the energy releases utilized in the currently prevailing LMFBR safety evaluations. Although the resultant pressure acting on the walls of the PCRV varies with the particular design, the two sample cases indicate that no apparent difficulty is encountered in designing the PCRV to sustain those higher loads. The computer code is established as a valuable tool to study the PCRV response. It serves as a means to locate critical areas of the particular design. Parameter- or sensitivity studies could thus be made with great efficiency. As an example, one interesting and somewhat unexpected result of the illustrations presented is the occurrence of circumferential cracks through the walls of the PCRV.

8491 (CONF-770817—2) **Overview of core disruptive accidents.** Marchaterre, J.F. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 9p. Dep. NTIS, PC A02/MF A01.

From International seminar on containment of fast breeder reactors; San Francisco, California, USA (22 Aug 1977).

An overview of the analysis of core-disruptive accidents is given. These analyses are for the purpose of understanding and predicting fast reactor behavior in severe low probability accident conditions, to establish the consequences of such conditions and to provide a basis for evaluating consequence limiting design features. The methods are used to analyze core-disruptive accidents from initiating event to complete core disruption, the effects of the accident on reactor structures and the resulting radiological consequences are described.

8492 (CONF-770817—3) **Assessment of accident energetics in LMFBR core-disruptive accidents.** Fauske, H.K. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

From International seminar on containment of fast breeder reactors; San Francisco, California, USA (22 Aug 1977).

An assessment of accident energetics in LMFBR core-disruptive accidents is given with emphasis on the generic issues of energetic recriticality and energetic fuel-coolant interaction events. Application of a few general behavior principles to the oxide-fueled system suggests that such events are highly unlikely following a postulated core meltdown event.

8493 (CONF-770817—4) **Application of containment codes to LMFBRs in the United States.** Chang, Y.W. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From International seminar on containment of fast breeder reactors; San Francisco, California, USA (22 Aug 1977).

The application of containment codes to predict the response of the fast reactor containment and the primary piping loops to HCDAs is described. Five sample problems are given to illustrate their applications. The first problem deals with the response of the primary containment to an HCDA. The second problem deals with the coolant flow in the reactor lower plenum. The third proem concerns sodium spillage and slug impact. The fourth problem deals with the response of a piping loop. The fifth problem analyzes the response of a reactor head closure. Application of codes in parametric studies and comparison of code predictions with experiments are also discussed.

8494 (CONF-770817—5) **Core debris behavior and interactions with concrete.** Baker, L. Jr. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

From International seminar on containment of fast breeder reactors; San Francisco, California, USA (22 Aug 1977).

Post-HCDA, core-debris behavior is considered in three locations: (1) within the reactor vessel, (2) within the cavity below the reactor vessel, and (3) within the concrete below the reactor cavity. In-vessel behavior is dominated by considerations of the fragmentation of molten fuel and steel on quenching in an excess of sodium to form particulate debris beds. In-vessel coolability depends primarily on the availability of sufficient horizontal surface area so that the particulate bed depth is not excessive and on the requirement that removal of small quantities of heat from the reactor vessel continues.

Core debris behavior in the reactor cavity can be controlled in several different ways. An uncooled cavity liner could maintain its integrity for many days while the decay heat is absorbed by sodium boiloff from the cavity. An engineered cooling system in the cavity could result in the permanent coolability of core debris in the cavity. Such a system could be based on one of four general concepts, including (1) the cooled crucible concept, (2) the sacrificial barrier concept, (3) the stable barrier concept, and (4) the catch tray concept. Each concept has a different set of advantages and disadvantages. However, each would appear to be a viable approach to core retention.

8495 (COO—2571-9) **Improvement and verification of fast reactor safety analysis techniques. Progress report, April 1, 1977—June 30, 1977.** Barker, D.H.; Wheeler, P.A. (Brigham Young Univ., Provo, Utah (USA). Dept. of Chemical Engineering). 1977. Contract EY-76-S-02-2571. 17p. Dep. NTIS, PC A02/MF A01.

An energy balance was made to determine the effect of the latent heat of vaporization of fuel and steel on temperature changes of the fuel and steel. Calorimeter runs were made on the reaction of DMSO with acetyl chloride to determine the effects of concentration and injection speed on the power of the reaction. Within a limited range, the power is proportional to both the concentration and injection rate. A plot of void fraction as a function of concentration was made. The concentration at which the reaction suddenly produces a large void fraction is between 3 and 4 molar.

8496 (EPRI-NP—112) **Rod bundle test facility instrumentation description, calibration, and uncertainty analysis, PWR blowdown heat transfer project. Final report.** Hsia, A.H.; Hubbard, F.R. III; Schneider, R.E. (Combustion Engineering, Inc., Windsor, Conn. (USA); Columbia Univ., New York (USA). Dept. of Chemical Engineering). Aug 1977. 258p. Dep. NTIS, PC A12/MF A01.

The instrumentation used during the rod bundle blowdown heat transfer tests, conducted at the Heat Transfer Research Facility of Columbia University, are described and measurement uncertainty analyses are performed. The uncertainty studies are generally based on single-phase steady state instrument performance, two-phase characteristics are discussed, and limiting errors estimated. Where possible, steady state steam-water data is used to substantiate theoretical uncertainty bounds.

8497 (EPRI-NP—113) **Rod bundle blowdown heat transfer tests simulating pressurized water reactor loss of coolant accident conditions. Final report.** Hsia, A.H.; Hubbard, F.R.; Schneider, R.E. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Aug 1977. 218p. Dep. NTIS, PC A10/MF A01.

An experimental program has been conducted to investigate transient critical heat flux (CHF) in pressurized water reactor (PWR) cores during a hypothetical loss-of-coolant accident (LOCA). Twenty-seven (27) powered blowdown transients were performed in the test program. Loop and test section parameters were selected to simulate predicted average reactor core blowdown thermal-hydraulic conditions. All experiments were performed with a 25 (5 x 5 square array) rod bundle test section having a uniform axial heat flux profile. The rod bundle had an active heated length of 12.5 feet. The test results are discussed, including the experimentally determined times and locations of CHF.

8498 (EPRI-NP—443) **Characteristics of instrumentation and control system failures in light water reactors.** Basin, S.L.; Burns, E.T.; Cini, V.; Loell, W.S. (Science Applications, Inc., Palo Alto, Calif. (USA)). Aug 1977. 70p. Dep. NTIS, PC A04/MF A01.

Characteristics of instrumentation and control (I and C) system failures, including set-point drift problems, are discussed. Specific topics included in the discussion are: general trends in the occurrence of I and C failures, principal reactor systems affected, variation in I and C failure rate over time and the impact of I and C problems on plant availability. A total of 977 I and C failure events and 640 set-point drift events, reported by LWR licensees, provided the basis for the observations and conclusions presented.

8499 (GA-A—14277) **Primary coolant system response to an HTGR core heatup.** Deremer, R.K.; Dunn, T.D.; Cadwallader, G.J.; Grenier, R.M.; Silady, F.A.; Wakefield, D.J. (General Atomic Co., San Diego, Calif. (USA)). Jul 1977. Contract EY-76-C-0167-051. 15p. (CONF-770708—15). Dep. NTIS, PC A02/MF A01.

From Thermal reactor safety meeting; Sun Valley, Idaho, United States of America (USA) (31 Jul 1977).

Consequences of an unrestricted core heatup in an HTGR were assessed as part of the ERDA-funded probabilistic risk assessment study titled "Accident Initiation and Progression Analysis" (AIPA). The original objective of the AIPA study was to provide guidance for safety research and development programs for HTGRs. Public risk from the unrestricted core heatup events in the HTGR were found to be relatively low. With public risk as a criterion for further safety research, the uncertainty on PCRV and containment integrity in a core heatup transient was recommended. Thus, since publication of the seven-volume AIPA Status Report in 1975-76, ERDA has sponsored a task on this subject. Volume VIII addressed the 175 comments made by reviewers. Several critics believed that failure modes other than failure to isolate the containment should be considered in the core heatup sequences and therefore provided further impetus to the research recommendation to examine long-term effects of the decay heat on these structures. The paper presents some highlights of this task. Emphasis has centered on the convection flow paths, the fission product decay heat redistribution, and the PCRV top head thermal barrier and concrete degradation. Included are descriptions of the following: the event scenario and the block diagram for the principal initiating event leading to an unrestricted core heatup; the modeling and results of the primary coolant pressure transient and natural convection flow patterns prior to depressurization to the containment; the thermal model of the core including the time- and space-dependent decay heat source term; the top head component failure modes, times, and effects including the results of modeling fallen, degraded concrete on the top reflector. The conclusions of each analysis area are summarized.

8500 (GEAP—10207-38) **Reactor primary coolant system pipe rupture study. Progress report No. 38, October—December 1976.** (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Feb 1977. 22p. NTIS $4.00.

The pipe rupture study is designed to extend the understanding of failure-causing mechanisms and to provide improved capability for evaluating reactor piping systems to minimize the probability of failures. Following a detailed review to determine the effort most needed to improve nuclear system piping (Phase I), analytical and experimental efforts (Phase II) were started in 1965. The progress report summarizes the recent accomplishments of a broad program in (a) basic fatigue crack growth rate studies focused on LWR primary piping materials in a simulated BWR primary coolant environment, and (b) studies directed at quantifying weld sensitization in Type-304 stainless steel.

8501 (HEDL-TI—75001-10) **FSAR Q_1 responses.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1977. Contract EY-76-C-14-2170. 67p. .

Supplementary information related to the FFTF final Safety Analysis Report is presented. (DG)

8502 (Juel-Conf—21) **Proceedings of the fourth Indo-German seminar on operation of nuclear power plants. Session 7.** Schiffer, M. (comp.). (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Sep 1976. 569p. (CONF-7606139—). Dep. NTIS (US Sales Only), PC A24/MF A01.

From 4. Indo-German seminar on operation of nuclear power plants; Julich, German, Federal Republic of (F.R. Germany) (29 Jun 1976).

The individual papers were abstracted separately for the data base.

8503 (KFK—2416, pp 50-59) **Detective rod and accident experiments.** Plitz, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

Fuel element behaviour of the SNR-300 during possible operational incidents is of particular interest for reasons of economy. Programmes for investigating the effects of operational incidents on the behaviour of fuel elements, and the behaviour of defective fuel rods during continued operation, are therefore carried out. The experimental incident programmes (performance and coolant incidents, cyclic operation, overload) and the programme concerning defective rods are introduced. The problem in connection with the Na-fuel swelling process is dealt with.

8504 (KFK—2416, pp 42-49) **Core elements during ramp powers and incidents.** Toebbe, H.; Gestermann, F. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

Three modes of operation are taken as the basis of design for the core elements of the SNR 300, from which dissimilar design criteria are derived. Fuel rod behaviour during reactivity and coolant throughput is dealt with. Three examples of incidents, the loads during which and their effect on the core elements are explained and assessed, demonstrate that the core elements meet with the design requirements in cases of typical incidents.

8505 (LA-UR—77-1599) **Multi-dimensional fluid-structure interactions in a pressurized water reactor.** Dienes, J.K.; Hirt, C.W.; Stein, L.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 21p. (CONF-771120—3). Dep. NTIS, PC A02/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, Georgia, USA (27 Nov 1977).

Sudden loss of coolant in a pressurized water reactor due to failure of a coolant pipe would result in flashing of the coolant accompanied by the propagation of a rarefaction wave into the downcomer. A computer program that simultaneously calculates the behavior of the coolant and the accompanying motion of the core support barrel which is considered as a three-dimensional shell with both membrane and bending stresses is discussed.

8506 (LA-UR—77-1994) **Summary of structural safety analysis of HTGR core supports.** Anderson, C.A.; Bennett, J.G. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 9p. (CONF-770929—7). Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, New York, USA (15 Sep 1977).

A summary of analyses carried out to understand the behavior of the High Temperature Gas Reactor support system when subjected to earthquake and long-term loadings is presented.

8507 (NEDO—21596) **Mark III Confirmatory Test Program: 1/root 3 scale condensation and stratification phenomena, Test Series 5807.** Varzaly, A.M.; Grafton, W.A.; Chang, H.; Mitchell, M.K. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Mar 1977. vp. Electric Co., San Jose, CA.

A series of steam and liquid blowdown tests was performed to evaluate condensation phenomenon and suppression pool thermal stratification for the Mark III Pressure Suppression Containment System. The tests were conducted at the General Electric Pressure Suppression Test Facility in San Jose, California. The volumetric scale factor of the facility was 1:130, based on the BWR/6-251 series Mark III containment design. The pool and vent system both represented $1/3$ flow area scale mockups of an 8^0 sector of the Mark III containment, including three $15\frac{7}{8}$ in. (403 mm) diameter horizontal vents. The test parameters were simulated break size, initial suppression pool temperature, and saturated liquid or vapor blowdown. Particular emphasis was placed on pool dynamic response to a simulated loss-of-coolant accident, including chugging phenomenon, containment wall, weir wall, and vent loading and pool thermal response.

8508 (NEDO—24010) **Technical bases for the use of the Square Root of the Sum of Squares (SRSS) method for combining dynamic loads for Mark II plants.** Singh, A.K.; Tagart, S.W.; Subramanian, C.V. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Jul 1977. vp. Electric Co., San Jose, CA.

This report describes the methods and bases for the use of Square Root of the Sum of the Squares (SRSS) rule for combining co-directional components of dynamic response for Mark II plant. Numerical computations were conducted for a total of cases of load combinations for actual Mark II systems, structures and components using the dynamic loading combinations specified in the DFFR for earthquake, LOCA and suppression pool dynamic loadings. The Square Root of the Sum of the Squares (SRSS) rule has been extensively used in dynamic analysis of nuclear power plants. The justification for the use of the SRSS rule is the observed low probability for the peak dynamic responses occurring simultaneously even though the various components of the same event (e.g., earthquake) or different events (e.g., earthquake and S/RV discharge) occur at the same time. The reasoning behind use of the SRSS rule is quantified through the use of probability theory in this study.

8509 (ORNL/NUREG/TM—129) **Fuel Aerosol Simulant Test (FAST) plan.** Wright, A.L.; Smith, A.M.; Kress, T.S. (Oak Ridge National Lab., Tenn. (USA)). 14 Sep 1977. Contract W-7405-ENG-26. vp. Dep. NTIS, PC A02/MF A01.

This report presents the work plan for the Fuel Aerosol Simulant Test (FAST), which constitutes task 5 of the Aerosol Release and Transport (ART) Program, sponsored by the Division of Reactor Safety Research of the Nuclear Regulatory Commission. These tests involve the study of the formation, rise, and condensation of a surrogate LMFBR fuel (UO_2) vapor bubble produced in liquid sodium to simulate phenomena associated with hypothetical core-disruptive accidents (HCDAs). UO_2 bubbles will be produced by the capacitor discharge vaporization (CDV) technique. Tests through FY 1979 will be done in argon, water, and in sodium; results will be analyzed using models developed in the ART program.

8510 (PB—269339) **Critical experiments, measurements, and analyses to establish a crack arrest methodology for nuclear pressure vessel steels. Quarterly report no. 9, Oct—Dec 1976.** Gehlen, P.C.; Hahn, G.T.; Hoagland, R.G.; Kanninen, M.F.; Marschall, C.W. (Battelle Columbus Labs., Ohio (USA)). Jun 1977. Contract AT(49-24)-0293. 59p. NTIS PC A04/MF A01.

A comparison between the BCL one-dimensional and two-dimensional dynamic fracture models was made using experimental crack propagation results from a transparant plastic as a basis for the comparison. Both models gave essentially the same results in good agreement with experiment with regard to the important features of the fracture events, e.g. length of crack jump, and the variation in the instantaneous stress intensity and crack velocity with crack tip position during propagation. Materials used were steel A533 B and A508 and Araldite. Three compact tension (CT) geometry specimens were cut from previously machined single-edge-notch (SEN) specimens. These specimens were provided with larger diameter loading pins with the aim of reducing the specimen-load system interaction which had a pronounced influence on the crack propagation events in the previous SEN experiments. The influence of externally supplied energy during crack propagation was examined in some detail. An approximate relation was derived to indicate the magnitude of the error introduced into K sub D data obtained from the measurement of crack jump distance.

8511 (PB—269686) **A phenomenological correlation for post-CHF heat transfer.** Chen, J.C.; Sundaram, R.K.; Ozkaynak, F.T. (Lehigh Univ., Bethlehem, Pa. (USA). Dept. of Mechanical Engineering and Mechanics). Jun 1977. Contract AT(49-24)-0180. 157p. NTIS PC A08/MF A01.

A phenomenological model for heat transfer in the post-critical-heat flux regime was developed on the basis of additive vapor and liquid transport mechanisms at the hot wall. The vapor heat transfer was derived from momentum-transfer analogy. A semi-empirical correlation for thermodynamic non-equilibrium was used to predict actual-qualities and superheated vapor temperatures. The liquid heat transfer was modeled as a transient three step process, involving liquid superheating at the hot wall, bubble nucleation, growth, and disruption of liquid mass, and evaporation of the residual liquid film. The area fraction of wall cooled by liquid was taken to decrease exponentially with increasing wall superheat. The overall correlation permits prediction of local heat flux, actual quality, and vapor temperature using values of local pressure, mass flow rate, equilibrium quality, and wall temperature as input information. In comparison with data for water boiling in tubes, from eight different experimental sources, the average deviation between calculated and experimentally derived values were 3.7% in actual-quality (for 2186 data points), and 14.2% in heat flux (for 3641 data points, at pressures up to 2200 psia).

8512 (SAND—77-0161C) **Mobile helium cooling loop system for in-reactor PAHR experiments.** Brammer, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 8p. (CONF-771109—22). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

One objective of the PAHR program at Sandia Laboratories is to better simulate the decay heating of debris beds and molten pools by using the Annular Core Pulse Reactor (ACPR) operated in its steady-state mode to fission heat UO_2 fueled PAHR experiment capsules. Safe performance of these typically long duration, elevated temperature PAHR experiments within the ACPR first necessitated the development of a unique system for cooling, control, and diagnostics of the PAHR experiment capsule. The experimental equipment arrangement of the mobile helium cooling loop (HCL) system connected through piping to the PAHR debris bed capsule located at the bottom of the 23 cm diameter by 7 m long dry experiment tube penetrating the core region of the pool-type ACPR reactor is described. The mobile HCL system uses low pressure helium gas to remove heat at rates up to 20 kW that was fission generated within the sealed capsule containing UO_2 and molten sodium.

8513 (SAND—77-1014C) **Coded aperture imaging of reactor illuminated LMFBR fuel pins.** Kelly, J.G.; Stalker, K.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 5p. (CONF-771109—37). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

As a part of Sandia Laboratories program to study simulated core disruptive accidents in reactor safety research, a fuel motion detection system based on coded aperture imaging is being developed. Until the experiments reported here were conducted it was not known whether either of two important questions could be properly answered. First, could an actual fuel pin illuminated by a reactor be imaged with a coded aperture and an active detector system with acceptable frame rates and spatial resolution. Second, could collimator and shield structures be fabricated for the Annular Core Pulsed Reactor (ACPR), for which the system is being built, that would provide acceptable signal to background ratios. Both of these questions can now be answered in the affirmative because of the favorable experiments recently conducted at the Sandia Pulsed Reactor (SPR II) and at the ACPR.

8514 (SAND—77-1016C) **Hydrodynamic analysis of the LMFBR prompt burst excursion (PBE) experiment.** Young, M.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 7p. (CONF-771109—7). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

A series of in-pile experiments has been conducted at Sandia Laboratories to provide information on pressure levels and conversion of thermal energy into mechanical work in LMFBR cores during hypothetical, superprompt-critical excursions. Pressures generated in these experiments are recorded by a pressure transducer located at the top and bottom of a sodium channel surrounding a single, fresh UO_2 fuel pin. Work energy conversion is measured by a linear motion transducer connected to a piston at the top of the sodium column. Since the pressure transducers are located fairly far from the location of pin failure, it becomes necessary to determine the effect of channel geometry and piston motion on the observed pressure data. A two-dimensional, hydrodynamic analysis of pressure pulse propagation in the fuel pin-coolant channel geometry was therefore performed using the CSQII computer code. The initial series of PBE experiments consists of single, fresh UO_2 pins surrounded by a sodium-filled or dry-coolant channel contained in a closed test capsule. The capsule is subjected to a maximum pulse in the Annular Core Pulse Reactor (ACPR) resulting in an energy deposition of from 2350 to 2900 J/g (14 and 20 percent enriched pins). The pulse width at half maximum (PWHM) is about 5 ms.

8515 (SAND—77-1017C) **Effect of thermal stress on oxide crusts.** Ostensen, R.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-771109—9). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

In the transition phase in LMFBR hypothetical accidents, the existence of an insulating crust of frozen fuel between molten fuel and cold structure is of key importance. The disruption of such a crust for fuel flowing through the axial blanket regions can lead to rapid freezing and subsequent blockage formation. In a boiling pool of molten fuel and steel, the presence of the crust may be necessary in order to reduce the convective heat transfer rate and allow a subcritical boilup. This paper describes the effect of thermal stress on such a crust and points out that such crusts may be far weaker than previously believed.

8516 (SAND—77-1032C) **Rate effects in the dynamic vaporization of uranium dioxide.** Benson, D.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 6p. (CONF-771109—23). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

Information for vaporizing UO_2 at temperatures and vaporization rates appropriate to fast reactor safety analysis is now becoming available from several different types of experiments. These data are summarized and compared to models used in reactor safety analysis. It has been commonly assumed in fast reactor analysis that the vaporization of fuels at high temperatures can be described by an equation of state for material in chemical and thermal equilibrium. However, the comparisons of dynamic experiments in oxide material to equilibrium measurements produce contradicting results. These observations can be resolved by a rate dependent effect in the high temperature oxide.

8517 (SAND—77-1059C) **Large scale sodium interactions. Part 2. Preliminary test results for limestone concrete.** Smaardyk, J.E.; Sutherland, H.J.; King, D.L.; Dahlgren, D.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-771109—47). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

Any sodium cooled reactor system must consider the interaction of hot sodium with cell liners, and given either a failed liner or a hypothetical core disruptive accident, the interaction of hot sodium with concrete. The data base available for safety assessments involving these interactions is limited, especially for the concrete and failed liner interactions. To better understand what happens when hot sodium comes in contact with concrete, a series of tests is being carried out to investigate sodium-concrete reactions under conditions which are similar to actual reactor accident conditions. Tests cover the cases of sodium spills on bare concrete and on cells with defective steel liners. Specific objectives have been to obtain a complete description of the sodium/concrete interaction including heat balance, gas evolution and flow, movement and heat generation of the reaction zone, reaction product formation, and the layering or movement of the products.

8518 (SAND—77-1073C) **Large scale sodium interactions. Part 1. Test facility design.** King, D.L.; Smaardyk, J.E.; Sallach, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 7p. (CONF-771109—46). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

During the design of the test facility for large scale sodium interaction testing, an attempt was made to keep the system as simple and yet versatile as possible; therefore, a once through design was employed as opposed to any type of conventional sodium "loop." The initial series of tests conducted at the facility call for rapidly dropping from 20 kg to 225 kg of sodium at temperatures from 825°K to 1125°K into concrete crucibles. The basic system layout is described. A commercial drum heater is used to melt the sodium which is in 55 gallon drums and then a slight argon pressurization is used to force the liquid sodium through a metallic filter and into a dump tank. Then the sodium dump tank is heated to the desired temperature. A diaphragm is mechanically ruptured and the sodium is dumped into a crucible that is housed inside a large steel test chamber.

8519 (SAND—77-1092C) **Network model of free convection within internally heated porous media.** Conrad, P.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 6p. (CONF-771109—15). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

A hypothetical core-disruptive accident (HCDA) in a liquid metal fast breeder reactor (LMFBR) may result in the formation of an internally heated debris bed. Considerable attention has been given to postulated mechanisms by which such beds may be cooled. It is the purpose of the work described to demonstrate a method for computing the heat transfer from such a bed to the overlying sodium pool due to single-phase, free convection.

8520 (SAND—77-1093C) **Thermal behavior of concrete.** Knight, R.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 7p. (CONF-771109—18). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

The treatment of post accident containment problems requires an understanding of concrete when subjected to high temperatures due to thermal contact with molten core materials and/or coolant. Sodium spills on concrete are of special concern because the resulting chemical reactions are collectively exothermic. Among other possible safety problems, the gas released by the thermal decomposition of concrete has the potential of producing pressures sufficient to endanger the integrity of cell liners. Insight into these phenomena has been gained by constructing a computer model and performing a series of studies. The code presently calculates the following quantities as functions of space and time: (1) temperature of the cell liner, (2) temperature of the concrete, (3) ablation rate of the heated concrete surface, (4) the water, water vapor, and carbon dioxide evolution rates, (5) the total gas discharged, and (6) the decomposition energy absorption rate for each decomposing species. The code has been used to predict the decomposition of concrete both with and without a containment liner.

8521 (SAND—77-1095C) **Large scale sodium interactions. Part 3. Chemical phenomena with limestone concrete.** Sallach, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-771109—27). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

The description of the chemical processes and reaction products resulting from the exposure of concrete to molten sodium metal is important for a thorough, realistic assessment of the safety of CRBR-type reactors. Concretes are in general complex heterogeneous substances whose ingredients can be derived from many sources. Consequently a wide variety of reaction processes and products might be anticipated. Initial attention has focused on a concrete in which both the aggregate and sandy components are derived from limestone. Presented are the chemical observations and experimental data from tests in which molten sodium metal at approximately 500°C is dropped into cold limestone concrete crucibles. Thermocouples immersed in the sodium pool indicate that the reaction proceeds in two stages. In the first stage which lasts 5 to 8 minutes, the temperature of the reacting mass hovers around 500°C. This stage is followed by a second stage of longer duration—greater than 100 minutes—where the temperature is 700 to 800°C. The main reaction product is a hard, fused, black slag which contains about 3/4 of the sodium in the initial charge. A secondary product is sodium oxide aerosol which accounts for the remaining 1/4 of the charge. It is significant that no free sodium metal is found in the slag; all sodium has completely reacted.

8522 (SAND—77-1103C) **Value/impact comparison of alternate containment designs.** Carlson, D.D.; Hickman, J.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 6p. (CONF-771109—43). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

The Reactor Safety Study (WASH-1400) identified two characteristics important for comparing the relative value and impact of alternate containment designs. First, that the public risk from nuclear reactor accidents stems principally from Class 9 or core-meltdown accidents, and second, that the nature of the containment failure in the core-meltdown accident is a major factor in determining the

resultant public consequences. The present study used these two characteristics to identify a set of containment design alternatives which appear to provide the greatest potential for reducing public risk at the most reasonable cost.

8523 (SAND—77-1106C) **Steam explosion triggering experiments with oxidized Corium-E simulants.** Nelson, L.S.; Buxton, L.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-771109—45). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

Corium-E is a material which could possibly result from a hypothetical light water reactor (LWR) fuel melt accident. It would consist of molten UO_2 fuel, Zircaloy cladding, stainless steel structural material and lesser amounts of fission products. If molten Corium contacted water in a hypothetical fuel melt accident, it could possibly participate in a steam explosion. Previous work has shown that steam explosions can easily be triggered for a highly oxidized Corium-E simulant immersed in water but not so easily, if at all, for a highly metallic Corium-E simulant. Since details of the accident scenarios which would determine the exact oxidation state of the Corium are not fully understood, experiments to further investigate steam explosion triggering for Corium-E as a function of initial oxygen content have been performed. Six compositions of Corium-E simulants containing various amounts of initial oxygen were used. For simplicity, four-component simulants were used instead of the more complex multi-component mixtures expected in actual Corium-E. The metal-atom ratio was held constant in these mixtures with only the oxygen ratio varying.

8524 (SAND—77-1413C) **Sandia in-core molten fuel pool experiment results.** Plein, H.G.; Carlson, G.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 2p. (CONF-771108—1). Dep. NTIS, PC A02/MF A01.

From Post accident heat removal information exchange meeting; Chicago, Illinois, USA (2 Nov 1977).

The major initial objective of the in-core molten fuel pool program at Sandia has been to develop a versatile experiment in which relative heat fluxes and structural ablation could be studied using real materials under typical temperature and heating conditions. The initial experiment series is designed to prove containment design, test ultrasonic thermometers, and provide material interaction data. The first two molten fuel pool experiments, MP-1 and MP-2, were successfully conducted in the Annular Core Pulse Reactor (ACPR) on June 24 and July 29, 1977. These first two experiments demonstrated the adequacy of the experiment package for heating and containment of UO_2 to melt. They have shown the usefulness of ultrasonic thermometry for making multiple temperature measurements to the melting point of UO_2, but also indicated that some problems remain to be solved in this application of the technique.

8525 (TID—22794) **LOFT integral test system final safety analysis report.** (Idaho National Engineering Lab., Idaho Falls (USA)). Aug 1977. Contract EY-76-C-07-1570. 818p. Dep. NTIS, PC A99/MF A01.

Safety related information on the LOFT facility is presented under the following chapter headings: general facility description, experimental program, site and environment, reactor, mobile test assembly, containment facility, and engineered safety features.

8526 (TREE-NUREG—1149) **Experiment data report for semiscale Mod-1 test S-28-2 (steam generator tube rupture test).** Patton, M.L.; Sackett, K.E. (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1977. Contract EY-76-C-07-1570. 262p. Dep. NTIS, PC A11/MF A01.

Recorded test data are presented for Test S-28-2 of the Semiscale Mod-1 steam generator tube rupture test series. These tests are among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system. Test S-28-2 was conducted from initial conditions of 15 936 kPa and 558 K to investigate the response of the Semiscale Mod-1 system to a depressurization and reflood transient following a simulated double-ended offset shear of the broken loop cold leg piping. During the test, cooling water was injected into the cold leg of the intact and broken loops to simulate emergency core coolant injection in a PWR. For Test S-28-2, accumulator injection into the intact loop hot leg was provided to simulate simulate the rupture of six steam generator tubes.

8527 (UCID—17580) **Unsteady jet-slug dynamics.** Kang, S.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Sep 1977. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

The present analysis treats the transient load characteristics at the wet-well bottom during the vent-clearing event under loss-of-coolant accident conditions. A conceptual model is introduced wherein the liquid-jet inertia and the net momentum-efflux are the two dominant physical factors. The derived load-history equations were found to be functions of the vent-clearing characteristics and of the jet-decay mode in the liquid pool. The theoretical results obtained by a physical modelling of these phenomena appear to agree reasonably well with the available data from UCLA and from LLL 1/5-scale experiments.

8528 (UCID—17601) **Mass flowrates through the vent lines during air tests of the 1/5-scale Mark I BWR pressure suppression system.** McCauley, E.W.; Pitts, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1977. Contract W-7405-ENG-48. 103p. Dep. NTIS, PC A06/MF A01.

Mass flowrates per downcomer show that three vent lines connecting the drywell to the toroidal wetwell test sections are matched within 10% on 19 of 23 applicable air tests. Vent line flow coefficients determined for the first 0.3 seconds after the start of drywell pressurization are within 20% of calculated values.

8529 (UCID—17605) **Mark I 1/5-scale boiling water reactor pressure suppression experiment comparison of experimental data to an analytical computer model.** Sterbentz, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. Contract W-7405-ENG-48. 100p. .

This report was designed to compare graphically the experimental data from the Lawrence Livermore Laboratory's 1/5-scale Boiling Water Reactor Pressure Suppresion Facility with the computer model, CONTEMPT-LT. The comparison involves the transient pressure behavior in the drywell and the 7.5 and 90 wetwell sectors. All tests used in the comparison were conducted with a perfect gas (no steam tests). Specifically, the experimental air clearing tests were driven by pressurized nitrogen (N2) gas. The comparison was done for tests involving variable drywell overpressure, drywell pressurization rate, downcomer submergence and different geometries using restricting and blind orifices in the vent pipes. The results indicate that the major parameters effecting the correspondence between the experimental data and CONTEMPT-LT are the drywell pressurization rate and the restricting orifice plates.

8530 (UCID—17625) **1/64 scale model tests of a Mark I boiling water reactor pressure suppression system.** Pitts, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 21p. Dep. NTIS, PC A02/MF A01.

Results of air blowdown experiments, conducted on a detailed 1/64 scale model of a Mark I BWR pressure suppression system, show no difference in observed phenomena between tests with the full 360° toroidal wetwell and tests with a 90°, 45° or 22-1/2° sector of the toroidal wetwell. Phenomena observed qualitatively on the 1/64 scale apparatus had the same characteristics as those observed in later tests on the 1/5 scale apparatus. Bubble action and pool swell were largest in regions where the downcomers were closely spaced. Blocking one of the eight vent lines had insignificant effects on the results.

8531 (WCAP—8587(Rev.1)) **Methodology for qualifying Westinghouse PWR-SD supplied NSSS safety related electrical equipment.** Jordan, W.G.; Lorentz, D.G.; Miller, R.B. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). Sep 1977. vp. Electric Corp., Pittsburgh, PA.

The purpose of the report is to describe the methodology that Westinghouse PWRSD has adopted to qualify safety-related electrical equipment to IEEE-323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations." This methodology represents the Westinghouse interpretation of this standard and will be applied in the development of qualification plans and documentation of qualification.

8532 (WCAP—9150) **Westinghouse Emergency Core Cooling System evaluation model. Modified October 1975 version.** Johnson, W.J.; Thompson, C.M. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). 1976. vp. Electric Corp., Pittsburgh, PA.

The report presents modifications to the Westinghouse Emergency Core Cooling System (ECCS) evaluation model. It is recommended that these modifications be incorporated for all future applicable ECCS design calculations.

8533 **Calculation of accident doses to equipment inside containment of power reactors.** Kolar, M.J. (Gilbert/Commonwealth, Jackson, MI); Olson, N.C. *Nucl. Technol.;* **36**: No. 1, 56-64(Nov 1977).

A mathematical model was developed to calculate the dose to equipment inside containment of power reactors following a maximum hypothetical accident (MHA). The model permitted both instantaneous and time-dependent releases and incorporated decay chains up to six isotopes in length. The release of noble gases produced by the decay of halogens that plate out on surfaces or are trapped by filters was taken into account. The resulting equations were solved analytically. The gamma and beta dose due to an MHA from a 3-GW(th) reactor was computed using this model. Results show that the use of decay chains produces a 38% increase in dose,

and an instantaneous release produces a dose that is 14% higher than the time-dependent release.

8534 Consideration of the effect of iodine plateout on containment post-loss-of-coolant accident doses. Normand, E. (Sargent and Lundy Engineers, Chicago). *Nucl. Technol.;* **36**: No. 1, 65-73(Nov 1977).

The effect of halogen plateout sources on containment post-loss-of-coolant accident dose rates has been evaluated. The main approach utilized has been to compare the dose rates due to halogen plateout and halogen immersion (or atmospheric) sources, assuming each is comprised of an equal inventory of radioiodines. Based on the parameters chosen, including the use of only the primary ^{131}I photon, 0.36 MeV, for all calculations, the gamma-ray dose rate from the atmospheric component will always dominate over the plateout component for full containment configurations. However, for small chambers within the containment, the atmospheric and plateout dose rates are relatively comparable, so that determining which is greater depends on the location of the dose point.

8535 Post-loss-of-coolant accident doses to pressurized water reactor equipment. Kolar, M.J. (Gilbert/Commonwealth, Jackson, MI); McCarty, J.R.; Olson, N.C. *Nucl. Technol.;* **36**: No. 1, 74-78(Nov 1977).

Safety-related equipment located inside the containment boundary of a pressurized water reactor must be qualified to withstand a radiation dose caused by a design-basis accident. Because of uncertainties in establishing the radiation dose, a margin of safety should be included. An analysis was performed of a core melt accident, a hypothetical accident, and a design-basis accident and a conclusion reached that a safety margin should be added to the loss-of-coolant accident dose.

8536 Production of molten UO_2 pools by internal heating: apparatus and preliminary experimental heat transfer results. Chasanov, M.G.; Gunther, W.H.; Baker, L. Jr. (Argonne National Lab., IL). *Nucl. Technol.;* **36**: No. 1, 120-128(Nov 1977).

The capability for removal of heat from a pool of molten fuel under postaccident conditions is an important consideration in liquid-metal fast breeder reactor safety analysis. No experimental data for pool heat transfer from molten UO_2 under conditions simulating internal heat generation by fission product decay have been reported previously in the literature. An apparatus to provide such data was developed and used to investigate heat transfer from pools containing up to 7.5 kg of UO_2; the internal heat generation rates and pool depths attained cover most of the ranges of interest for postaccident heat removal analysis. It was also observed in these studies that the presence of simulated fission products corresponding to approximately 150,000 kW-day/kg burnup had no significant effect on the observed heat transfer.

8537 Simulation of fast breeder reactor pin behavior using UO_2 pins with direct electrical heating. Alexas, A. (Kernforschungszentrum, Karlsruhe, Ger.). *Nucl. Technol.;* **36**: No. 1, 129-138(Nov 1977).

In the electrical pin burst facility of the GfK, out-of-pile experiments are performed to simulate the in-pile behavior of fuel pins under SNR-300 accident conditions. Preliminary results of the first experimental series indicate that failure phenomena such as cladding meltdown, fuel melting, and fuel motion, and failure times can be studied by the method of the direct electrical heated UO_2 pin in a satisfactory and reproducible manner. Theory and experimental results will be compared at a later time with the computer program VESUV.

8538 Calculation of the fragmentation of UO_2 by capacitor discharge: nonequilibrium model. Alsmiller, R.G. Jr.; Perez, R.B.; Barish, J. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **36**: No. 1, 139-147(Nov 1977).

A model based on phase-space considerations is developed to describe the fragmentation of UO_2 by capacitor discharge, i.e., to predict such quantities as the amount of gas and liquid produced, the number of liquid fragments, the number distribution of the molecules in the liquid fragments, the kinetic-energy distribution of the gas and liquid fragments, etc. This model cannot give a unique numerical prediction of all of these quantities based only on the initial-state specification, but it does enable all of these quantities to be expressed in terms of the average internal energy of a gas molecule in the final state, the average binding energy of a UO_2 molecule in a liquid fragment in the final state, and the average number of molecules in a liquid fragment in the final state.

8539 Identification of nuclear systems. Kerlin, T.W. (Univ. of Tennessee, Knoxville); Zwingelstein, G.C.; Upadhyaya, B.R. *Nucl. Technol.;* **36**: No. 1, 7-38(Nov 1977).

A great deal of information about a nuclear power plant and the coefficients that describe it is contained in the data that can be collected in plant transients. Much of this information is difficult or impossible to obtain from steady-state measurements. Significant advances have been made in developing techniques to extract the desired performance-related or safety-related information from transient data records. Techniques are available for determining such specific design parameters as reactivity feedback coefficients or heat transfer coefficients. Models, either derived from physical principles or developed empirically, can be tuned by comparison with plant data, and they are capable of very accurate predictions of plant responses to disturbances. Efficient methods, with on-line computing capability, can track performance-related parameters to yield information on plant conditions for surveillance purposes. Methods such as these provide expanded capability for extracting useful information from operating plants.

8540 Effect of internal circulation on the heat transfer of a nuclear reactor containment spray droplet. Chung, J.N.; Ayyaswamy, P.S. (Univ. of Pennsylvania, Philadelphia). *Nucl. Technol.;* **35**: No. 3, 603-610(Oct 1977).

Heat removal rates from containment spray droplets following a loss-of-coolant accident in a nuclear reactor have been calculated by three different droplet models: the complete mixing model, the model with internal circulation, and the rigid sphere. Irrespective of the model, the thermalization time is found to increase with increasing droplet size. It is noticed that the thermalization times predicted by the complete mixing and nonmixing models either underestimate or overestimate the value provided by the internal circulation model. It is concluded that the effect of internal circulation cannot be ignored in estimating heat removal rates from spray droplets.

8541 Influence of the RSK on the safety standard. The role of the Reactor Safety Commission in licensing procedures for nuclear facilities. Birkhofer, A. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching/Muenchen (Germany, F.R.)); Jahns, A. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 4, 191-194(Apr 1977). (In German).

The RSk has played a central role in elaborating and advancing the safety standard of nuclear facilities in the FRG. It assesses whether the technical requirements for licensing are fulfilled but also gives special consideration to basic problems. For PWR and BWR reactors, general safety specifications were compiled in so-called guidelines which have gone far to standardize the requirements made on safety conceptions. RSK recommendations cover the nuclear fuel cycle and nuclear waste management as well as safety assessments of the HTR and SNR reactors. Experience from the operation of nuclear facilities is taken into account as far as possible. The methods of reactor safety have yielded good results.

8542 RECA3: a computer code for thermal analysis of HTGR emergency cooling transients. Petersen, J.F. San Diego, CA; General Atomic Company (1977). vp. (GA-A—14520; GA-LTR—22).

The RECA3 computer code was developed to calculate the transient thermal responses of important HTGR primary system components under emergency cooling conditions. Included are simulations of the core and primary coolant behavior, the emergency cooling system performance, selected primary system components and, for the Fort St. Vrain design only, the PCRV top head and the liner cooling system. The results are used primarily to validate the safe cooldown capability of an HTGR design under a broad spectrum of postulated accident conditions. A key feature which distinguishes RECA3 from related HTGR accident analysis codes is the relatively high level of detail incorporated into the core model. Core block and coolant temperatures are calculated at nodal points by performing a finite difference solution of the system of nodal-point energy balance equations. The nodal points are established by a radial-circumferential subdivision which corresponds to the refueling region boundaries and by an axial subdivision of the layers of fuel, reflector, and core support blocks into any desired number of levels. Heat conduction between nodal points is treated three-dimensionally. A system of one-dimensional momentum balance equations is solved for the distribution of the applied core coolant flow among the refueling regions. The solution includes special provisions which allow the flow through a refueling region to reverse its direction. Therefore, the effects of local upflows which tend to occur when buoyant forces become dominant can be simulated.

8543 Activities of the Illinois Commission on Atomic Energy, 1975—1977. Springfield, IL; Illinois Commission on Atomic Energy (1977). 59p. (NP—22418).

This report presents the activities and programs of the Illinois Commission. Activities reported include: physical security of nuclear facilities; transport of radioactive materials; nuclear safety; radiolgical emergency assistance; and one-stop siting. The Sheffield low-level waste burial site and the Reed-Keppler Park problem are discussed. A reprint of nuclear energy in Illinois for 1976-2000 is included. Reports by various state agencies are also included. Recommendations by the Commission are listed.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 8197

MAGNETIC

REFER ALSO TO CITATION(S) 9449, 9461

PUMPED HYDRO

8544 (PB—268323) **Research into the impact on electrical equipment from variable speed operation of pumped-storage plants. Final report.** Lipo, T.A. (General Electric Co., Schenectady, N.Y. (USA)). 8 Apr 1977. Contract DI-6-07-DR-50090. 182p. (SRD—77-063). NTIS PC A09/MF A01.

The report summarizes work conducted to determine the effect of operating electrical equipment of pumped-storage plants over a variable frequency range of 30 to 81 Hz. The motivating factor behind the study was the desire to improve pumped-storage hydro efficiency. The reversible Francis type pump-turbine represents a compromise design to achieve a best overall efficiency at constant speed for a particular head. The variable speed concept would allow speed to change with head variations while maintaining optimum pump-turbine efficiency over the entire head range. The electrical equipment considered includes the generator/motor, excitation equipment, switchgear and bus, metering, surge protection, relaying, and power transformer. Converter harmonics and the converters effect on system power factor are analyzed for the generator/motor. A simulation study was conducted on a hybrid computer to identify potential system problems which arise from variable speed operation.

FLYWHEELS

REFER ALSO TO CITATION(S) 8734, 8745

8545 (N—77-22484) **Safety flywheel.** Schneider, R.T. (National Aeronautics and Space Administration, Washington, D.C. (USA)). 17 Jan 1977. 11p. NTIS PC A02/MF A01.

The patent application relates to an inertial energy storage device employing a safety flywheel which is made of flexible material such as a twisted rope ring. The rigidity required for such a device is achieved through centrifugal forces inherent in such a device when it is operating. A small number of the strands of the rope ring have a tensile strength that is lower than the vast majority of the strands of the rope ring whereby should any of these strands fail, they will begin to whiplash allowing such a failure to be detected and braked before a catastrophic failure occurs. This is accomplished by the inclusion of glass tubes located around the periphery of the flywheel. The tubes are in communication with a braking fluid reservoir. The flywheel and glass tubes are enclosed within a vacuum-tight housing.

8546 (UCID—17592) **Bibliography of flywheel energy storage systems.** Henry, E.A.; Johnson, K.W.; McMurphy, F.E.; Quick, T.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1977. Contract W-7405-ENG-48. 345p. Dep. NTIS, PC A15/MF A01.

The bibliography, containing 382 references, was issued especially for the 1977 Flywheel Technology Symposium in San Francisco, Oct. 5-7. The citations are divided into categories covering properties of flywheels, flywheels in vehicles, flywheels in utilities, flywheels in aircraft and space vehicles, overview of energy resources, and fiber composite properties. (TFD)

8547 (Y—2097) **Composite flywheel development, April 1—June 30, 1977.** Huddleston, R.L.; Kelly, J.J.; Knight, C.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

Additional experimental prestressed rim evaluations indicate that this technique should permit near full utilization of Kevlar-49 hoop strength in a prestressed flywheel rim with resultant energy densities up to 44 Wh/lb. A finite-element model of the Deltawrap flywheel was generated, and several analyses were made. Design of the containment assembly hardware is 90% complete.

THERMAL

REFER ALSO TO CITATION(S) 8230, 8644, 8668, 8677, 8682, 8683, 8714

8548 (COO—2990-6) **Investigation of metal fluoride thermal energy storage materials: availability, cost, and chemistry. Final report, July 15, 1976—December 15, 1976.** Eichelberger, J.L. (Pennwalt Corp., King of Prussia, Pa. (USA). Technological Center). Dec 1976. Contract EY-76-C-02-2990. 320p. Dep. NTIS, PC A14/MF A01.

Storage of thermal energy in the 400 to 1000°C range is attracting increasing consideration for use in solar power, central power, vehicular, and commercial process systems. This study investigates the practicality of using metal fluorides as the heat storage medium. The projected availability of metal fluorides has been studied and is shown to be adequate for widespread thermal storage use. Costs are projected and discussed in relation to thermal energy storage applications. Phase diagrams, heats of fusion, heat capacities, vapor pressures, toxicity, stability, volume changes, thermal conductivities, fusion kinetics, corrosion, and container materials of construction for a wide range of fluorides have been examined. Analyses of these data in consideration of thermal energy storage requirements have resulted in selection of the most cost-effective fluoride mixture for each of 23 temperature increments between 400 and 1000°C. Thermo-physical properties of these 23 materials are presented. Comparison of fluoride with non-fluoride materials shows that the fluorides are suitable candidates for high temperature applications on the bases of cost, heat capacity/unit volume, heat capacity/unit weight, corrosive properties, and availability.

8549 (PB—267281) **Transpiration heat transfer in thermal energy storage devices.** Peavy, B.A.; Dressler, W.E. (National Bureau of Standards, Washington, D.C. (USA)). May 1977. 32p. (NBSIR—77-1237). NTIS PC A03/MF A01.

The storage of thermal energy at a suitable temperature level from sources such as solar energy or waste heat processes can make that energy available for space heating at a later time period. This report is concerned with sensible heat transfer that takes place in a thermal storage device composed of a porous material with a fluid (water) transpiring through it. Experiments were performed on a prototype thermal storage device and the results were compared to numerical values computed from an analytical model.

BATTERIES

8550 (CONF-770148—) **First annual ERDA battery contractors coordination meeting.** (Energy Research and Development Administration, Washington, D.C. (USA); Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 362p. Dep. NTIS, PC A16/MF A01.

From 1. annual ERDA battery contractors coordination meeting; Germantown, Maryland, USA (27 Jan 1977).

This ERDA Battery Contractor's Coordination Meeting was held in Germantown, Maryland, on January 27 to 28, 1977. Papers were presented on battery requirements for various applications and development programs for conventional and advanced batteries. This report contains only viewgraphs, figures, and tables from the papers; the texts are not included. (RWR)

DESIGN AND DEVELOPMENT

8551 (ANL-K—3723-1) **Design and cost study of a nickel—iron oxide battery for electric vehicles. Volume II. Public report. Final report.** (Westinghouse Electric Corp., Tampa, Fla. (USA). Tampa Div.). 23 Aug 1977. Contract W-7405-ENG-38. 73p. Dep. NTIS, PC A04/MF A01.

A nickel—iron oxide battery design concept is proposed which will meet the performance and cost objectives for a viable electric-vehicle battery. This design is based to a large extent on proven past practice, but incorporates those design improvements which are expected to be realizable within a two-year development program. Developmental problems have been addressed, and the methods of solution, identified. The manufacturing cost of the proposed design is identified for annual production quantities of 1,000, 10,000, and 100,000 25-kWh batteries. Based on the high-volume estimates of material, labor, and capital requirements, a selling price of $60/kWh was found to be attainable. Battery test requirements were identified which will serve to define the performance characteristics of interest to a potential user. A follow-on R and D program plan, detailed in a separate proprietary report, was developed which combines significant electrode and cell development with demonstrations of performance and potential costs in the form of prototype hardware. Because of the extensive background in nickel iron technology, including recent developments in both the nickel and iron electrode technologies, the risk associated with the proposed development is considered to be small. This combines with excellent cost and performance projections to make the nickel—iron battery the most attractive contender for near-term electric vehicle application. 18 figures, 25 tables.

8552 (COO—2566-22) **Ford/ERDA sodium—sulfur battery development, Phase II. Progress report No. 22, July 1—July 31, 1977.** Topouzian, A. (Ford Motor Co., Dearborn, Mich. (USA)). Aug 1977. Contract EY-76-C-02-2566. 22p. Dep. NTIS, PC A02/MF A01.

Specific results in the areas of container and seal development, development of ceramic electrolyte and seal technology, and cell fabrication and testing are reported. Mo foil withstood corrosion by polysulfides at 400°C well. Thermal expansion and elasticity coefficients were determined for β''-alumina. Capacity yields and life characteristics are tabulated. 1 figure, 6 tables. (RWR)

PERFORMANCE AND TESTING

8553 (N—77-24583) **Effect of pulsed current charging on the performance of nickel—cadmium cells. Final report.** Bedrossian, A.A.; Cheh, H.Y. (Columbia Univ., New York (USA). Dept. of Chemical Engineering and Applied Chemistry). Jan 1977. Contracts NAS7-100;JPL-953970. 225p. (NASA-CR—153200). NTIS PC A10/MF A01.

The effect of pulsed current charging on the charge acceptance of Ni—Cd cells in terms of mass transfer, kinetic, and structural considerations was investigated. A systemic investigation on the performance of Ni—Cd cells by pulsed current charging was conducted under a variety of well-defined charge—discharge conditions. Experiments were carried out with half cells and film electrodes. The system behavior was studied by charge acceptance, mechanistic, and structural measurements.

8554 (SAND—77-0434) **Thermal cell polarization studies.** Levy, S.C.; Reinhardt, F.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 24p. Dep. NTIS, PC A02/MF A01.

Thermal cells containing a reference electrode were discharged under varying conditions. The drop in voltage during the plateau portion of discharge and end of life is explained in terms of polarization characteristics of the anode and cathode. 14 figures, 1 table.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 8808

APPLICATIONS

REFER ALSO TO CITATION(S) 8198, 8199, 8732, 8734, 8737, 8739, 8740, 8741, 8742, 8744, 8745

8555 (CONF-770112—, pp 485-501) **Definition study for photovoltaic residential prototype system.** Shepard, N.F. Jr. 1977.

From Proceedings of ERDA solar photovoltaic program; San Diego, California, United States of America (USA) (18 Jan 1977).

In Proceedings of the ERDA semiannual solar photovoltaic program review meeting, Silicon Technology Programs Branch.

The Residential Prototype System Test (RPST) is defined as a prototype experimental photovoltaic power system which is integrated into a conventional single-family residential structure. The six month definition study was intended to analyze the performance, conduct the conceptual design, plan the testing program and specify the test equipment requirements for such an experimental residence. Since RPST installations are currently planned for several regional site locations, this program also included a site selection evaluation.

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 8231

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 8565, 8578, 8598, 8605, 8646, 8647, 8648, 8649, 8651, 8652, 8654

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 7884, 8569, 8578, 8592, 8606, 8646, 8647, 8648, 8649, 8650, 8651, 8662, 8691, 9486

8556 (BNL—50668) **Annual report for fiscal year 1976, July 1975—September 1976.** Meier, P.M. (ed.). (Brookhaven National Lab., Upton, N.Y. (USA)). Dec 1976. Contract EY-76-C-02-0016. 116p. Dep. NTIS, PC A06/MF A01.

The BNL Regional Studies Program is part of a national effort supported by the U.S. Energy Research and Development Administration (ERDA) to create an energy assessment capability sensitive to regional conditions, perceptions, and impacts. Within ERDA, this program is supported by the Division of Technology Overview and includes, in addition to a concern for health and environmental impacts of energy systems, analysis of the complex trade-offs between economics, environmental quality, technical considerations, national security, social impacts, and institutional questions. The Brookhaven Program focuses on the Northeast including the New England States, New York, Pennsylvania, New Jersey, Maryland, Delaware, and the District of Columbia. The content of the program is determined through an identification of the major energy planning issues of the region in consultation with state and regional agencies. A major component of the program in 1976 was the Northeast Energy Perspectives Study which examined the implication of alternative energy supply-demand possibilities for the region. In 1977 a major component is the northeast portion of the National Coal Utilization Assessment carried out in collaboration with several other laboratories in other regions of the United States.

8557 (PB—268291) **Energy and income in arkansas.** Opitz, J.H.; Troutman, F.H. (Arkansas Univ., Little Rock (USA). Industrial Research and Extension Center). May 1977. 34p. NTIS PC A03/MF A01.

This study examines the impact of the use of different energy sources on income for the state of Arkansas. The rising price of energy affects income directly, through higher prices for goods and services, and indirectly as energy-using industries shift their location to energy-producing states. Arkansas, with personal income lower than the national median, and presently an importer of energy, faces a significant loss of income if energy prices continue to rise and if reliance on present sources of energy persists. The study examines the economic impact of using coal (primarily Western low-sulfur coal) and Arkansas lignite (lower in energy content and higher in sulfur).

8558 (PB—268370) **Public hearing before Transportation and Communications Committee on public utility rates, held August 24, 1976, Trenton, N.J.** (New Jersey General Assembly Transportation and Communications Committee, Trenton (USA)). 1976. 134p. NTIS PC A07/MF A01.

The purpose of the legislative hearing was to enable the Committee to hear expert testimony and to ask questions about alternative methods to the existing utility rate structure. Since utility rate-changing is a complicated and sophisticated process, which has numerous ramifications and consequences, it was essential that the Committee be given the opportunity to discuss with expert witnesses the various effects of a lifeline rate.

8559 (PB—268405) **Petrodollar recycling: the problem that seemed to go away. Final report.** Dunn, R.M.; Krulwich, S. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). Jan 1977. 33p. NTIS PC A03/MF A01.

This report examines the petrodollar problem, focusing on why the problem has not disappeared, but continues to pose potential difficulties for the world's economy. Of key importance are potential difficulties for the less-developed countries and the world's monetary system.

8560 (PB—268481) **Study of electric and gas utilities and the Public Service Commission of Nevada.** (Nevada Legislative Council Bureau, Carson City (USA). Legislative Commission). Sep 1976. 114p. NTIS PC A06/MF A01.

A partial listing of contents includes: alternative sources of energy; utility industry financing requirements; study of environmental laws; Study of Public Service Commission of Nevada; and energy conservation.

8561 (PB—268541) **The state land development plan. Land development element of the State Comprehensive Plan.** (Florida State Dept. of Administration, Tallahassee (USA). Bureau of Comprehensive Planning). Apr 1976. 151p. (DSP-BCP—22-76). NTIS PC A08/MF A01.

This proposed element of the State Comprehensive Plan has been prepared by the Department of Administration, pursuant to Chapter 23, Florida Statutes. It includes goals, objectives and policies broad in scope, that can affect the quality of life in Florida. The element was developed by the Bureau of Comprehensive Planning, Division of State Planning, in cooperation with state agencies, regional planning councils, and representatives of private and public groups.

8562 **Energy, jobs, and the cost of living.** Commoner, B. St. Louis; Washington University (1977). 32p.

From Conference on energy: its availability and use is everybody's concern; Los Angeles, California, USA (15 Jan 1977).

The energy crisis is still here, but it has "gone underground," Barry Commoner says. In fact, it is worse, he concludes, and is the

driving force of inflation, a stumbling block to industrial development, a threatening portent of massive unemployment. The effects of the energy crisis are far-reaching, and particularly in California. A review of that situation in California shows that environmental risks must be weighed in relation to energy supplies. Dr. Commoner says that when all facts are examined, it is not necessary to choose between jobs and environmental quality. He reviews a report prepared by TRW, Inc. concerning the strategy that industrial management is planning in Southern California to substitute alternate fuels for natural gas: the precautions necessary for the application of alternate fuels are summarized. The financial aspects and the reasons some sources have not been developed are cited. Dr. Commoner believes the development of solar energy conversion, and particularly for California, is "not only technically and economically sound, it is also politically realistic." (MCW)

8563 Energy problems of non-OPEC developing countries 1974-80. Lambertini, A. *Finanzierung Entwicklung.;* **13**: No. 3, 24-28(Sep 1976). (In German).

3 tabs.

In view of the soaring prices of natural oil and other energy carriers, how can the small investment budget be used for the energy sector without impairing economic development in other fields. The authors studies the energy carriers and the energy demand of non-OPEC developing countries and discusses their future prospects.

8564 Keynote address. Commoner, B. St. Louis; Washington University (1976). 15p. (CONF-761187—1).

From Annual meeting of the Congress of Cities National League of Cities; Denver, Colorado, USA (29 Nov 1976).

Dr. Commoner says U.S. cities are in crisis--each year the quality of urban life becomes worse; the problems multiply; costs escalate; and bankruptcy threatens. Further, he states that "hope" is the worst casualty. All attempts at solving urban problems have faltered. He feels that nearly all of the troubles stem from two economic issues--unemployment and inflation. After discounting the old maneuver (shifting the cities' problems to the Federal Government), Dr. Commoner proposes a new idea: that the key to the unemployment and inflation problems is a new energy policy, and that the cities can take the lead in creating it. Six basic facts are discussed that need to be known in order to connect energy, unemployment, inflation, and the fate of the cities. He feels these facts present "the real meaning of the energy crisis. It is not the distant propsect of some day running out of energy. Rather, it is the immediate prospect of economic catastrophe." (MCW)

8565 Life-cycle cost and economic analysis of a private owner or investor. Fleming, W.S. (William S. Fleming Associates, Manlius, NY). pp 180-188 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The system performance, economic analysis, and life-cycle cost proposal to The Columbian Rope Co. (Auburn, New York) in conjunction with the construction of their new factory and office building were analyzed. The HVAC and lumination systems were analyzed. Various possible energy sources and building systems were examined in terms of current and future cost, availability, and characteristics pertinent only to the company. (MCW)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 7885, 8556, 8561, 8732, 9020, 9021

8566 (NP—22469) **Illinois EPA and Illinois coal: citizens guide to better understanding.** (Illinois Environmental Protection Agency, Springfield (USA)). Jul 1977. 19p. Environmental Protection Agency, Springfield.

The efforts of the Illinois Environmental Protection Agency in achieving and maintaining air quality standards without reducing the use of Illinois high-sulfur (2 to 5%) coal are described. Illinois has large reserves of this coal recoverable by present methods and its continued usage in Illinois, and also in other surrounding states, is important to the state's economy. The efforts involved repeal of the emission standards where they did not affect air quality, temporary use of supplementary control systems, changes in allowable emissions if the source can demonstrate that air quality will not be affected, and extension of the date that sources outside Chicago, Peoria and East St. Louis must comply with the sulfur dioxide standard. Coal-gasification projects have been encouraged, and the Agency has worked on a case-by-case basis to encourage use of Illinois coal. The report is a citizens guide to a better understanding of the economic and environmental factors involved. (LTN)

8567 (PB—267443) **Interagency energy/environment research and development program: status report III.** Laska, R. (Mitre Corp., McLean, Va. (USA). METREK Div.). Apr 1977. Contract EPA-68-01-3188. 62p. (M—77-19). NTIS PC A04/MF A01.

This report describes the EPA-planned, and coordinated Interagency Energy/Environment RandD Program. The report is comprised of three sections. The introduction describes the history, purpose, and scope of the Interagency Program. The second section describes project activity in the five Process and Effects categories. The third section describes projects underway in the nine Control Technology categories.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 8580, 8585, 8659

8568 (PB—268107) **A Kentucky energy resource utilization program. Semiannual report, 1 Jul—31 Dec 1976.** (Kentucky Univ., Lexington (USA). Inst. for Mining and Minerals Research). Feb 1977. 75p. (IMMR—26-PR4-77). NTIS PC A04/MF A01.

This report describes progress on the Kentucky Energy Resource Utilization Program during the six-month period from July 1, 1976 to December 31, 1976. These projects are in four major divisions -- Mining, Geology and Reserves, Process Development, and Materials Analysis.

8569 Coping with future technology. Sorrows, H.E. (National Bureau of Standards, Washington, DC). *Commer. Am.;* **2**: No. 20, 4-5(26 Sep 1977).

A collaborative effort between government, industry, and the scientific community is needed to support expanding and increasingly complex technology. Industrial and technological growth were aided in the past by abundant, high-quality natural resources and the minimum of regulation that accompanied a climate of free enterprise. New trends toward technology-intensive consumer goods, an imperfect diffusion and exploitation of technology, and underinvestment by industry in research that could lead to new technology are now in evidence. The economic implications of these trends result from the need to increase national productivity while protecting the environment, maintain international trade while preserving high employment and wages, and providing the goods for a rising standard of living while coping with resource depletion. A way is outlined for developing the needed partnership that could remove impediments and allow a coordinated economic and resource development program to proceed. (DCK)

8570 Energy and water resources. Corvallis, OR; Oregon State University (1977). 121p. (NP—22464).

Seminar conducted by Oregon State University Water Resources Research Institute, Fall Quarter 1976.

Some issues concerning the availability, quality, institutional constraints, and environmental aspects of water resources are examined in the nine papers presented at the seminar. Spokesmen were from the academic field, government agencies, and private organizations. Papers presented were: How Much Water for Energy, by Jack A. Barnett; Energy, Water Resources, and Agriculture, Dr. Larry Boersma; Energy Conservation in Irrigation, Dr. Robert B. Wensink; Geothermal Energy and Water Resources, Dr. Don Karr; Solar Energy and Water Resources, Dr. Daniel K. McDaniels; Hydro-Power and Pumped Storage in the Northwest, Orval Bruton; Energy and Water Diversion, Dr. Peter C. Klingeman; Energy Consumption of Advanced Wastewater Treatment, Don Hernandez; and The Impact of Irrigation on the Columbia River, Robert F. Vining. (MCW)

8571 Case for alternative energy sources. Hartnett, J.P. (ed.). (Univ. of Illinois, Chicago). pp 19-38 of In Alternative energy sources. Hartnett, J.P. New York; Academic Press (1976).

The oil embargo in the fall of 1973 followed by the four-fold increase in the price of oil has had major international repercussions. Prior to the embargo the major industrialized countries of Western Europe and North America as well as Japan had become increasingly dependent on low-cost oil as a major energy source. This was also true for the developing countries, which depended on petroleum products not only for their energy needs but also as a source for modern fertilizers so necessary for increased agricultural productivity to meet the needs of their growing populations. Currently a worldwide reevaluation of energy sources and energy needs is under way. A review of recent energy-consumption patterns, coupled with the impact of increased oil prices, leads to the conclusion that many countries will be forced for economic and geopolitical reasons to turn to alternative energy sources including nuclear power and increased use of coal, solar energy, geothermal energy as well as energy conservation.

8572 Conservation of resources. London; Chemical Society (1976). 254p. (CONF-7604141—).

From Conservation of resources symposium; Glasgow, UK (5 Apr 1976).

The book is a collection of 16 papers presented at the Annual Chemical Congress which give a very broad picture of the problems of conservation both in the United Kingdom and in the world as a whole. The papers consider energy requirements of different communities and the wide disparity between the demands of the industrialized and Third World countries; the need for economy and the importance in due course of finding renewable forms of energy; very substantial losses of energy that take place when oil and coal are converted into electricity or when sources of energy have to be transported. The problems of nuclear energy are discussed and, in a consideration of the involvement of the chemical industry in energy, proposals are made for reducing the input of energy in the manufacture of chemicals. (MCW)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 8567, 8569, 9486

8573 (NSF-RA—76-0007) **1975 technology transfer directory of people. A list of persons interested in the process of technology transfer.** Jolly, J.A. (Naval Postgraduate School, Monterey, Calif. (USA)). 1976. 83p. Science Foundation, Washington, DC.

A list of approximately 1800 persons expert in agriculture, forestry, and fishing; mining; construction; manufacturing; transportation and public utilities; wholesale trade; finance, insurance, and real estate; services; and public administration are included in the directory. Addresses, areas of interest and expertise, and employment association are included. (MCW)

8574 Energy research in a small country. Goedkoop, J.A. (Stichting Energieonderzoek Centrum Nederland, Petten). *Econ. Stat. Ber.;* **62**: No. 3104, 472-476(18 May 1977). (In Dutch).

The director of the Netherlands' Energy Research Centre reviews the outlined plans and recommendations as proposed by the National Steering Committee on Energy and by the ministries of Science and Economic Affairs. Experience with nuclear energy research since 1955 should be taken as an example when shaping energy research and development programs in the near future. Research should be directed towards the needs of the industry producing equipment that serves energy production and towards international cooperation for the development of large energy systems.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 8044, 8063, 8107, 8114, 8418, 8420, 8421, 8422, 8423, 8424, 8543, 8609

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 8732, 8735, 8745

8575 Eminent domain: its origin, meaning, and relevance to coal slurry pipelines. Campbell, T.C. (West Virginia Univ., Morgantown). *Transport. J.;* **17**: No. 1, 5-21(Fal 1977).

The implications of eminent domain policies as they apply to coal slurry pipelines are under investigation by the Congressional Office of Technology Assessment to determine if further legislation is needed to acquire the rights of way for the proposed Wyoming-Arkansas line. The history of eminent domain as a concept is traced from its origins in the 17th Century. It has developed an association with the concept of common carriers, although the idea of public use and public interest developed later. Precedents at both the state and Federal level can be cited for the use of eminent domain when railroads and pipelines for oil and gas were built. Several states have enacted legislation specifically providing for eminent domain in the case of slurry pipelines. Pipeline interests, feeling that the railroads' refusal to let the pipelines cross existing tracks will make it impossible to deal at the state level, are pushing for Federal legislation on the grounds that economics and technology should dictate the pipeline route. Concerns have also been voiced over the possibility of environmental damage by agricultural and water interests. Questions about the regulation of slurry pipelines, the economic and technological problems, and the impact on the rail industry have been raised during the debate. 86 refs. (DCK)

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 8713

8576 (COO/4213—1/1) **Grid-connected integrated community energy system. Final report. Volume I. Executive summary.** (City of Independence, Mo. (USA)). Jul 1977. Contract EC-77-C-02-4213. 59p. Dep. NTIS, PC A04/MF A01.

An Integrated Community Energy System Program in Independence, Missouri is described and results of Phase I are summarized. Five tasks of Phase I are: preliminary energy analysis and institutional assessment, conceptual design of ICES, firming-up of commitments, and work management plan. The program involves developing a small coal-fired unit that can be effectively integrated into the total community environment. (MCW)

8577 Summary assessment of electricity cogeneration in industry. Widmer, T.F. Waltham, MA; Thermo Electron Corporation (1977). 8p. (NP—22339).

Data on electric power and industrial process-heat cogeneration are summarized. A program for promoting industrial cogeneration by changing regulatory policies and tax incentives is discussed. The potential capacity for cogeneration in U.S. industry is estimated for differing sets of policy assumptions. The potential savings in fuel and capital investment that could result from cogeneration are described. It is estimated that for 50,000 MW of added cogeneration capacity in 1985 as compared with 1975, 588,000 bbl/d of fuel could be saved relative to the fuel consumed by fossil-fuel power plants to produce that amount of electric power and that the net capital savings would be $24 billion. (LCL)

8578 Energy and system simulation analysis by computer for a Navy flight training facility to determine the economic feasibility of total heat recovery. Eldridge, B.G. pp 189-199 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The Navy now requires computerized energy and systems analyses on all new projects exceeding 10,000 ft^2 of floor space. The Naval flight training facility contains about 30,000 ft^2 of floor space. The specifications of all components are described. A Life-Cycle Cost analysis, complete with input data, criteria, operating schedules and loads, cost estimates of each system, life-cycle cost basis, formulas, legends, and all pertinent data was submitted for the facility. The most economical system was a total heat recovery system consisting of a centrifugal water-cooled refrigeration machine incorporating a double-bundle condenser to recover the waste heat from the condenser.

CONSERVATION

REFER ALSO TO CITATION(S) 8572, 8624, 8638, 8656, 8659, 8662, 8676, 8685, 8692

8579 (ORNL/EIS—114) **Transportation energy conservation data book: a selected, annotated bibliography. Edition 2.** Howard, E.B.; Barber, B.Y.; Jordan, A.C.; Seaborn, C.C. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 261p. Dep. NTIS, PC A12/MF A01.

Part II of ORNL—5320.

The 568 references in this bibliography reflect the continuing effort to compile information on energy conservation in the transportation field. The citations refer to both specific statistical information and general background coverage and were selected to be used in conjunction with the report "Transportation Energy Conservation Data Book." All references are abstracted and arranged alphabetically by author or corporate author if there is no personal author. In addition, a separate list of reports sponsored by the Energy Research and Development Administration, Division of Transportation Energy Conservation is included; indexes are provided by author, corporate author, sponsor, report number, keyword, and permuted title.

8580 Canada as a conserver society. Resource uncertainties and the need for new technologies. Ottawa; Science Council of Canada (1977). 108p. (NP—22637).

Canadian development in the past has depended on resources, transportation, and exports. On this, the other structures of goods and services production, commerce, education, law, and government that make a functioning society have developed. Resources depend

on natural endowment and wise management, and it is with this in mind that the authors contend it is time now to resort to a conserver economy. Constraints identified to challenge managers at all levels of Canadian society include: an awareness of the fragility of the biosphere; environmental problems moving from concern to action; demand to participate in decision making; realization that growth is not possible; culture and society are in a state of change; the growing trend toward regionalization and decentralization; a growing redundancy of labor arising from increasingly capital-intensive processes; and the emergence of the reality of limits. (MCW)

8581 Approach to innovative tax programs to stimulate energy conservation in existing commercial buildings. Volume I. Gilles, T.C. (Lennox Industries Inc., Marshalltown, IA). pp 158-169 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Strong evidence exists that energy conservation must be implemented in the existing commercial sector to sustain economic growth of that sector. This study has indicated that insufficient leverage exists with present energy costs, or even significantly increased energy costs, to provide an adequate incentive for major capital investments for energy use reduction in the existing sector. Further, in the commercial sector "pass through" of significant cost increases to the consumer will not occur if viable practical alternatives are available to the energy user to provide measurable competitive advantage. An example has been presented to reallocate the tax structure from one of close relationship to income tax to that of one related to energy use to provide the significant additional leverage to produce a realistic incentive to make major capital related investments to reduce the use of energy in the commercial sector.

8582 Energy conservation guidebook. Washington, DC; American Public Power Association (1975). vp. (NP—22441).

The Guidebook is designed to serve as a day-to-day reference for the consumer-owned electric utility. It should aid in handling energy shortages in such a way as to minimize any economic dislocation. The guidebook is divided into four segments: (1) The National Outlook; (2) How to Implement a Voluntary Electric Use Reduction Program; (3) How to Plan an Involuntary Curtailment Program; and (4) How to Encourage Energy Conservation in New and Remodeled Construction--Especially through Proper Insulation, Appliance Efficiency, Heat Pumps, and Efficient Lighting. Data from the Department of Water and Power of the City of Los Angeles are used as specific examples. (MCW)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 8601, 8605, 8613, 9521

8583 Our energy resources and future outlook. Karmohapatro, S.B. (Saha Inst. of Nuclear Physics, Calcutta (India)). *Sci. Cult.;* **43**: No. 1, 29-32(Jan 1977).

The share of various energy sources such as coal, gas, hydro, oil and nuclear in electricity generation in India is given for 1964 and estimated for 1985. After considering thorium breeder reactors and thermonuclear reactors as possible future sources, it is advised that to reach a target of at least 600 units of electricity generation per capita, India should depend on proven sources like coal and hydraulic systems. 10 refs.

8584 International energy situation: outlook to 1985. Washington, DC; Central Intelligence Agency (1977). 18p. (NP—22462). and Gift Div., Library of Congress, Washington, DC.

In the absence of greatly increased energy conservation, projected world demand for oil will approach productive capacity by the early 1980s and substantially exceed capacity by 1985. In these circumstances, prices will rise sharply to ration available supplies no matter what Saudi Arabia does. This forecast is largely based on (a) an estimate that the USSR will change from an exporter to a substantial importer of oil, and (b) an examination of the supply capabilities of Organization of Petroleum Exporting Countries (OPEC) and non-OPEC countries. The underlying supply problem will be masked during the next few years because of greatly increased oil production from the North Sea and Alaska. Demand for OPEC oil should stabilize at near current levels through 1979. Then, between 1979 and 1985, increasing world demand and stagnating oil production in the major consuming counries will result in increased reliance on OPEC oil. Data from the major energy-consuming areas (USA, OECD Europe, Japan, and Canada) were used as a baseline for energy demand determinations through 1985. (MCW)

8585 Place and role of various energy resources in energetics of the future. Styrikovich, M.A. (National Committee for Heat and Mass Transfer, Moscow). pp 1-17 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

After reviewing the various energy sources and estimating future supplies, subject to numerous qualifications, future prospects are considered. In the long term, the author proposes that thermonuclear fusion and breeder reactors can supply the needed energy for a long time. In the short term, major adjustments will be required and the nature of these are suggested for developing and developed countries and especially for the USA, Japan, France and the USSR. The USA presently uses large quantities of oil for transportation and domestic heating. The only obvious solutions are increasing domestic oil production or the production of liquid fuels from oil sands, oil shales or coal, combined with economical compact cars and more public transportation; domestic liquid fuels can only be replaced by electricity (at considerable additional expense due to low overall efficiency unless heat pumps are used). The overall cost will be high due to capital cost, environmental and safety problems. Japan and France will undoubtedly convert from oil-fired power plants to nuclear energy. The USSR is in the best situation to meet the future with few cars and mostly public transportation, and large apartments with district heating from central power stations supplying heat and electricity in a combined cycle. The specific energy consumption of developing countries will lag behind that of developed countries due to lack of capital and skilled specialists. (LTN)

8586 Future energy alternatives for Colorado. Volume I. Golden, CO; Colorado Energy Research Institute (1976). vp. (NP—22612/1).

A program was established to identify problem areas, examine optional solutions, provide technical evaluation of alternate scenarios for action, and describe clearly defined energy futures or CASES (Colorado Alternative Scenarios Energy System). This document reports progress on this program. The overall project is structured around an analysis of the energy production-supply-processing-consumption system of Colorado. Projections are made for the various CASES examined, with emphasis on shorter-term matters to 1985. The four CASES examined are: the base case (the existing trends); the conservation case (resources and environment); the maximum production case; and the sudden-interruption case (possibilities of supply disruptions). (MCW)

8587 Summary report on future energy alternatives for Colorado. Golden, CO; Colorado Energy Research Institute (1976). 29p. (NP—22612).

Results are summarized from the study which featured four cases, (an existing trend or base case, a conservation case, the maximum production case, and a sudden-interruption case). It is concluded that solutions to the energy problem will entail a mixture of some of the elements from each case. It is generally found that future energy demand will depend on both the size of the population and the per capita energy consumption. (MCW)

8588 Future energy alternatives for Colorado. Volume II. Appendices A through K. Golden, CO; Colorado Energy Research Institute (1976). vp. (NP—22612/2).

The study to analyze the energy system of Colorado featured four scenarios or cases (base or existing trends, a conservation case, the maximum production case, and a sudden-interruption case). Data are contained in this volume (13 appendices) describing reports on various component studies and additional research dealing with the cases. It also includes the development of analytical tools for future application. (MCW)

8589 Energy development and related UNESCO activities. Berkovsky, B.M. (UNESCO, Paris). pp 39-57 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

Energy is one of the crucial keys to socioeconomic development. An analysis of past trends and future perspectives of energy consumption shows a significant increase in energy demand in the foreseeable future. The question as to whether the current method of energy production—combustion of fossil fuels—will cover future energy demand is examined. Although there is no immediate danger of the current method of energy production being unable to cover energy demand, the stock of fossil fuels will be exhausted within the foreseeable future and significant attention should be paid to the development of alternative sources of energy. The principal clean and renewable sources are discussed briefly along with ongoing research in these areas. The coordination and promotion of research in the field of fundamental scientific and technological energy problems is in the domain of UNESCO. UNESCO's activities in this field are described.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 7925, 8137, 8418, 8420, 8421, 8422, 8423, 8424, 8558, 8560, 8561, 8575, 8581, 8588, 8589, 8596, 9025

8590 (PB—268359) **Some comments on the president's energy program and alternatives to it. Final report.** Johnson, W.A.; Wyant, F.R. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). 20 Feb 1975. 42p. NTIS PC A03/MF A01.

This report analyzes the Administration's energy program announced by President Ford on January 15, 1975. It formed the basis of testimony before the House Ways and Means Committee at that time.

8591 (PB—268403) **Federal energy policy: a conflict of interests. Final report.** Johnson, W.A. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). 20 Oct 1975. 40p. NTIS PC A03/MF A01.

This report examines various conflicts of objectives in Federal energy policy making.

8592 (PB—269390) **Improving regulatory effectiveness in Federal/State siting actions. Alternative financing methods. Final report.** Evans, D.J. (Nuclear Regulatory Commission, Washington, D.C. (USA)). Jun 1977. 36p. NTIS PC A03/MF A01.

This report reviews the elements of a rational national energy policy. The review is followed by an exploration of alternative financing methods for energy planning. The financing depends on the assignment of lead responsibility for each element of energy policy making and the intergovernmental relationships involved. Several financings are required including Federal general appropriations, State general funds, and applicant fees. The recommended basic financing, however, would follow from a Federal Energy Tax coupled with tax credit provisions for State efforts. A tax of no more than 0.1 mill per kilowatt hour enacted at the national level could produce ample funds for (1) an equivalent tax on other fuels based on BTU equivalents; (2) tax credit provision that would transfer up to two-thirds mill per kilowatt hour from the Federal government to States; (3) a bonus incentive for regional planning; and (4) a conservation tax that would encourage a more significant response to conservation.

8593 **Congressman speaks up on energy and utility legislation.** Dingell, J.D. (House of Representatives, Washington, DC). *Public Util. Fortn.;* **100**: No. 8, 25-30(13 Oct 1977).

An interview with Michigan's long-term Congressman, John Dingell, elicits his opinions on the National Energy Act in view of Senate opposition to the House bill. He advocates minimum national regulatory standards so that states can proceed according to their inclinations and local conditions. The House version is designed to encourage both energy and capital efficiency through a better distribution of energy demand. He feels that utilities will benefit by cost justification requirements and regrets the misinformation and misunderstanding of the bill's intent by the Edison Electric Institute and others. He defends the idea of assessing stockholders rather than customers for the costs of advertising that is promotional and political in nature. The concept of intervenor financing is meant to allow the public rather than the government to get involved in ratemaking. President Carter's position on rate reform is felt to be compatible with the House bill. The Congressman also comments on legislation dealing with regulatory lag and capital formation, interconnections and antitrust, natural gas deregulation, synthetic fuels and liquefied natural gas, and nuclear plant licensing. (DCK)

8594 **Survey of management audits of utility operating performance and efficiency.** Rodgers, P.; Smith, J.E. Jr. Washington, DC; National Association of Regulatory Utility Commissioners (1976). 59p. (NP—22451).

Many state commissions are requiring utilities they regulate to undergo a management audit of utility operating performance and efficiency. Questionnaires were sent to the states on the subject and the results are summarized for all states. The purpose, nature, and advantages of a management audit are briefly described with specific excerpts from management audits of utilities in Illinois, Indiana, Missouri, New Jersey, New York, North Carolina, Oregon, Texas, and Virginia. (MCW)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 8608, 8609

COAL

REFER ALSO TO CITATION(S) 7885, 7918, 8566

8595 (ARP—42) **Some comments on the ERDA plan and program.** Moore, J.R.; Schlottmann, A. (Tennessee Univ., Knoxville (USA). Appalachian Resources Project). 26 Jan 1976. 9p. of Tennessee, Appalachian Resources Project, Knoxville.

Testimony presented to the House of Representatives Committee on Science and Technology, Subcommittee on Fossil Fuels, is critical of US ERDA's planning and research programs with respect to coal, namely: viewpoint is too long term (some policy issues e.g. reclamation requirements for surface mining, offshore drilling policies, regulatory policies with respect to natural gas, etc. will have important feedbacks and need to be determined in the near term); lack of regional analysis (regional impacts with respect to air quality standards, water requirements, manpower requirements, etc. could affect regional and industry growth); program discounts present issues (high-sulfur coal and what to do about it, over confidence in coal gasification, in retrofitting power plants to burn coal instead of gas or oil and with respect to fluidized bed combustion); and ignoring of interactions between energy policy and environmental issues and cutbacks and narrow focus research programs. (LTN)

PETROLEUM

REFER ALSO TO CITATION(S) 7952, 8007, 8008, 8009, 8559, 8584, 8997

8596 (PB—268357) **The international implications of the vertical divestiture of U.S. oil companies. Final report.** Johnson, W.A.; Messick, R.E. (George Washington Univ., Washington, D.C. (USA). Energy Policy Research Project). 25 May 1976. 38p. NTIS PC A03/MF A01.

This report examines the structure of OPEC and the performance of the international oil companies during the 1973-74 embargo with reference to proposals to divest U.S. oil companies from their foreign sources of oil.

8597 **Ceal conversion legislation. Part I. Hearings before the Subcommittee on Energy Production and Supply of the Committee on Energy and Natural Resources, United States Senate, Ninety-Fifth Congress, First Session on S. 272, S. 273, and S. 977, March 21 and 29, 1977.** Washington, DC; Committee on Energy and Natural Resources (1977). 919p. GPO.

The legislation on greater coal utilization before the committee includes S. 272 (requiring, to the extent practicable, electric power plants and major fuel-bearing installations to utilize fuels other than natural gas); S. 273 (requiring, to the extent practicable, new electric power plants and new major fuel-burning installations be constructed to utliize fuels other than natural gas or petroleum); and S. 977 (requiring, to the extent practicable, existing electric power plants and major fuel-burning installations to utilize fuels other than natural gas or petroleum). Statements were heard from seven senators and representatives from the following: American Electric Power Service Corp., American Boiler Manufactures Association, National Electric Reliability Council, Virgina Electric and Power Co., Fossil Power Systems, Houston Lighting and Power Co., other electric utility industry representatives, and the Federal Energy Adminstration. Additional material from the Wall Street Journal and the Washington Post is included. (MCW)

NATURAL GAS

REFER ALSO TO CITATION(S) 8032, 8560

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 7918, 8121

8598 (ERDA—76-129/4) **Synthetic liquid fuels development: assessment of critical factors. Volume IV. Energy/economic comparison of coal-based automotive energy supply systems.** Steele, R.V.; Sharma, K.J.; Dickson, E.M. (Stanford Research Inst., Menlo Park, Calif. (USA)). May 1977. Contract EY-76-C-03-0115. 125p. Dep. NTIS, PC A06/MF A01.

The comparison of options was focused on energy supply systems that could provide automotive energy. Six coal-based energy forms--gasoline refined from synthetic crude oil (syncrude), methanol, gasoline produced by Fischer-Tropsch synthesis, liquid hydrogen, liquid methane, and electricity--were analyzed in terms of cost and energy consumption. Using only coal-based energy forms promoted consistency in the comparison of options. The five synthetic liquid fuels could be used in conventional or modified internal combustion engines, while electricity was assumed for use in powering electric cars that employ an advanced battery such as lithium-sulfur. Included in the energy supply systems were coal mining, coal transport, coal conversion, product transport, refining (for syncrude only), and product distribution. The reslts of the cost analysis showed that syncrude/gasoline is the least costly option, followed

by methanol, methane, Fischer-Tropsch gasoline, hydrogen, and electricity. The costs of methane and methanol produced by in-situ gasification of coal were found to be lower than all options except syncrude/gasoline. When the efficiency of converting various fuels to motive power in an automobile is considered, the relative cost picture changes. Using nominal internal combustion engine efficiencies (subcompact car) for the five liquid fuels, and the electricity consumption for an advanced electric car, electricity is the lowest cost option on a cents per mile basis, followed by syncrude/gasoline, methanol, methane, hydrogen, and Fischer-Tropsch gasoline. The results of the energy analysis showed that the energy consumed in delivering 10^6 Btu of automotive fuel or electricity can range from a low of 0.8×10^6 Btu for syncrude/gasoline to a high of 2.5×10^6 Btu for Fischer-Tropsch gasoline. As in the cost analysis, the consideration of automotive energy efficiency results in a different picture for each option in terms of energy consumption.

8599 (NP—22606) **Commercialization of synthetic fuels: alternative loan guarantee and price support programs. Background Paper No. 3.** Montgomery, D. (Congressional Budget Office, Washington, D.C. (USA)). 16 Jan 1976. 40p. GPO.

The analysis provides background information about incentives for the development of commercial-scale synthetic fuels from coal, oil shale, and other sources, specifically urban wastes. With the President proposing a program to bring these programs into commercial production in the near future, price supports, loan guarantees, and construction grants were designed. The proposals and decisions facing Congress are discussed. Criteria for decision include: is there a need for synthetic fuel production; will private industry proceed without Federal intervention; what is the best mix of incentives; are the costs of the proposed incentives acceptable; and what are the technology mixes, the program levels necessary, the environmental considerations, and the employment impact. Discussions on the potential impact on the Federal budget and the timing of decision conclude the report. (MCW)

ELECTRIC POWER

REFER ALSO TO CITATION(S) 8560, 8582, 8597

8600 (NP—22620) **Statistics of the Florida electric utility industry, 1960—1975.** (Florida State Energy Office, Tallahassee (USA)). 20 Dec 1976. 267p. TIC.

This report was prepared to provide a single comprehensive source of accurate statistics on Florida's Electric Utility Industry. Data are compiled on generating capacity; net generation and fuel consumption; net peak loads; load factors; electrical losses; electricity sales and number of customers; County electrical data; cost of electrical service; fuel analysis; nuclear energy statistics; selected socio-economic, environmental, and climatic data; financial data; forecast data; and world electrical data. (MCW)

8601 (PB—268479) **Report of the Advisory Commission on Electric Power Alternatives. Final report.** (Michigan Governor's Advisory Commission on Electric Power Alternatives, Lansing (USA)). 2 Sep 1976. 104p. NTIS PC A06/MF A01.

This report examines the general trends in the rates of growth of the demand for electric energy both in the nation and in Michigan; assesses the accuracy of utility industry and state government projections of such electric energy demand growth; and discusses alternatives that will provide the consumers of Michigan with an adequate supply of electric power.

8602 **Electricity supply for the next half century.** Norman, H.B. *Trans. S. Afr. Inst. Electr. Eng.;* 111-122(May 1977).

Probable electricity requirements of South Africa in the next half century are established as well as the economically optimum mix of conventional generating plant needed to meet these requirements. The effects of limited resources of fuel, water, capital and manpower are discussed, and consideration is given to environmental aspects and possible alternative sources of energy for electricity generation.

8603 **National Electric Reliability Council 1976 annual report with reports from its regional councils and NAPSIC.** Princeton, NJ; National Electric Reliability Council (1977). 36p. (NP—22457).

The National Electric Reliability Council (NERC), formed voluntarily by the electric utility industry in 1968, and incorporated in 1975, directs its efforts to augment the reliability and adequacy of bulk power supply of the electric utility systems in North America. NERC consists of nine regional councils whose memberships comprise essentially all of the electric power systems in the United States and the Canadian systems in the provinces of Ontario, British Columbia, Manitoba, and New Brunswick. This eighth annual report summarizes the highlights of the activities of NERC during the past year, with comments on the progress and problems relating to the reliability and adequacy of bulk power supply in North America. It also includes reports from each of the nine regional councils and from the North American Power Systems Interconnection committee (NAPSIC), a companion organization which coordinates operating matters to promote and protect the reliability of operation among the electric utility systems of North America, and of the interconnected transmission network.

8604 **7th annual review of overall reliability and adequacy of the North American bulk power systems.** Princeton, NJ; National Electric Reliability Council (1977). 30p. (NP—22459).

A report by Interregional Review Subcommittee of the Technical Advisory Committee.

In this seventh annual review of the overall reliability and adequacy of the North American bulk power systems, NERC finds that the adequacy of electric power supply for the future is in jeopardy. The utility industry is presently restrained from providing an adequate future supply of electric energy. The consequences of this will inevitably result in: an era of an energy-limited economy for the U.S.; disruption of operations in the industrial sector; economic hardship to commercial establishments; reduced operating efficiency of the business community; adverse changes in lifestyle of the American people; and threats to the health and welfare of all citizens. A survey of the restraints shows that some of the more critical ones are: overlapping and conflicting governmental regulations impeding the siting and the timely completion of new generation and transmission facilities; conflicts that exist between environmental goals and energy requirements; lack of timely and adequate rate relief adversely affecting the ability of utilities to finance construction of facilities required for the future; existing and possible future impediments which will impact on the ability to develop the necessary coal and uranium fuels to supply future planned generation facilities; and lack of stable government policies relative to the supply of electric energy. (MCW)

8605 **Simulating Oregon's future electrical energy demand.** Devine, W.D. Jr.; Calligan, C.C.; Osborne, O.D. Corvallis, OR; Oregon State University (1977). 224p. (NP—22635).

A report of a research project sponsored by the Pacific Northwest Regional Commission.

The Oregon State Simulation Model (OSSIM) was developed to facilitate communication with state-level decision makers on the interrelated problems of economic growth, environmental quality, and energy consumption. Following the introductory chapter, Section II outlines the process used to construct and test the model and describes its components. The energy component is analyzed in Section III, wherein the determinants of electrical energy demand for the state are investigated. Section IV describes the three approaches that were employed to meet laison and training objectives. Secton V describes the model implementation. (MCW)

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 8577

8606 (PB—267090) **Laws needed to expedite electric generation schedules for the Pacific Northwest: financing, environmental laws, and siting and licensing procedures. Volume I. Financing Pacific Northwest electric generation.** Jourolmon, L.; Kell, R.M.; Jackson, R.C.; Keller, J. (Kell, Alterman and Runstein, Portland, Oreg. (USA)). 1976. Contract DI-14-31-0001-5234. 206p. NTIS PC A10/MF A01.

Volume I of the study investigates the changes in financing structure, administrative licensing, and environmental law which are necessary to expedite future electric power generation in the Pacific Northwest. The present roles of public and private utilities, direct-service industries, and the Federal government are reviewed. Existing areas of joint coordination, planning, and financing between these groups are described. The study discusses the financing of the existing electric power facilities in the Northwest. An estimate of needed future construction capital is made and alternative methods for raising this capital, at the lowest possible cost to the consumer are proposed. The study outlines a new role for the Federal government in financing new generation.

8607 (PB—267091) **Laws needed to expedite electric generation schedules for the Pacific Northwest: financing, environmental laws, and siting and licensing procedures. Volume II. Environmental laws and siting and licensing procedures.** Jourolman, L.; Kell, R.M.; Jackson, R.C.; Keller, J. (Kell, Alterman and Runstein, Portland, Oreg. (USA)). 1976. Contract DI-14-31-0001-5234. 207p. NTIS PC A10/MF A01.

Volume II of the study examines environmental law as it pertains to the construction of new power plants and the facility licensing process. Legal aspects of the National Environmental Policy Act of 1969, The Clean Air Act Amendments of 1970, The Water Pollution Control Act and The Atomic Energy Act are discussed. The present licensing status of new coal-fired and nuclear facilities in the Northwest are reviewed. Recommendations on legis-

lation to expedite the capitalization and construction of new generating facilities in the Northwest are made.

8608 (PB—267368) **Annual summary of cost and quality of electric utility plant fuels, 1976.** (Federal Power Commission, San Francisco, Calif. (USA). Bureau of Power). May 1977. 163p. NTIS PC A08/MF A01.

A partial listing of contents includes: cost and quality data, annual tables, 1976; origin-by-destination data, annual tables, 1976; destination-by-origin data, annual tables, 1976; and quantity of coal complying with 1976 sulfur regulations.

8609 **Fossil and nuclear fuel for electric utility generation requirements and constraints, 1977—1986.** Princeton, NJ; National Electric Reliability Council (1977). 29p. (NP—22458).

The National Electric Reliability Council has surveyed the fuel requirements for the production of electricity in the United States during the next ten years. Coal-fired generation is projected to continue to maintain its commanding role in electric power supply, averaging about 47% over the period 1977 to 1986. Nuclear generation is projected to increase its contribution to electric energy production from about 13% in 1977 to 28% in 1986, which results in nearly a four-fold increase in absolute quantity. Oil-fired generation is projected to hold its proportionate role at about 17% from 1977 through 1982 and then decrease to less than 15% by 1986. Gas-fired generation will decline by 58% over the same ten-year period from 2.6 billion MCF to 1.1 billion MCF, its proportion, however, decreasing from about 12% to 3%. Hydro generation will supply a decreasing proportion of electric power's needs, dropping from about 11 to 7% by 1986. Constraints dealing with the nation's inability to expand coal production rapidly enough and a bottleneck on its transport, the impossible demand on utilities to install scrubbers, the slowdown in the installation of light-water reactors, and regulations regarding the use of oil and gas as boiler fuels are discussed in detail. (MCW)

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 8586, 8587, 8625, 8735

8610 (DOT-TST—77-70) **Feasibility of developing low-cost measures of demand for public transportation in rural areas. Final report.** Byrne, B.F.; Neumann, E.S. (West Virginia Univ., Morgantown (USA). Dept. of Civil Engineering). Dec 1976. vp. NTIS.

The Appalachian region has many rural areas of limited accessibility. To improve the accessibility of the rural carless (poor, elderly, young, infirm) public transportation has often been suggested. The objective of the research is to develop a low-cost methodology for determining latent demand for public transportation in rural areas, i.e., to develop a data base of key socio-economic, highway network, and geographic variables which can be used to estimate latent demand along possible rural-transit routes. Data were collected on existing rural-transit operations in Planning Region VI of West Virginia (Monongalia, Taylor, Marion, Harrison, Doddridge, and Preston counties) by means of an on-off survey and an on-board questionnaire survey. Using these as indicators of demand, this information will be related to census data for the affected region to determine if a simplified modeling approach to estimate rural public transportation demand is feasible.

UNCONVENTIONAL SOURCES AND POWER GENERATION

8611 (PB—268301) **Unconventional energy sources. Study module (final).** Johnson, L.R.; Simmons, G.; Peterson, J. (Northwest Energy Policy Project, Portland, Oreg. (USA); Idaho Univ., Moscow (USA)). 1977. 278p. NTIS PC A13/MF A01.

This report reviews available literature and current state-of-the-art on unconventional energy sources: geothermal, biomass, ocean, wind, solar. It estimates quantities of energy available to the Pacific Northwest (Oregon, Washington, Idaho) and the costs of recovering and utilizing energy from these sources. The summary contains projections of the contribution of unconventional sources to Northwest energy needs. An annotated bibliography is included.

8612 **Alternative Danish energy planning.** Blegaa, S.; Josephsen, L.; Meyer, N.I. (Danmarks Tekniske Hoejskole, Lyngby); Soerensen, B. *Energy Policy*, **5**: No. 2, 87-94(Jun 1977).

In the spring of 1976 the Danish government published an energy plan for Denmark for the period up to 1995. An essential part of this plan was the introduction of five nuclear power plants in the Danish supply system. An alternative energy plan which excluded nuclear power was later published by a group of Danish scientists. It includes a relatively extended application of solar and wind energy, and also emphasises the use of decentralised fossil fuel plants with combined power production and district heating. The main features and data of the alternative Danish energy plan are examined and compared with the official government plan.

8613 (ERDA-tr—298) **Contribution to the analysis of the development of unconventional energy sources in Latin America.** Escobar, I.; Ibacache, M.E. (Inter-American Development Bank, Washington, D.C.). Apr 1977. Translation of Spanish report. 32p. Dep. NTIS, PC A03/MF A01.

The energy demand for Latin America will be satisfied by the end of the present century mainly through utilization of its conventional hydraulic and fossil resources. Nuclear energy will experience a great development in Argentina, Brazil, and Mexico in the coming 20 years. The electronuclear alternative in other Latin American countries will be considerable depending on the degree of industrialization, geographical location and the possibilities for interconne ting networks for transmission and distribution of electrical energy in the country considered and depending on reduction in design scale and savings made in nuclear reactors presently in use (dropping down to capacities of about 150 MW per plant). The development of wind energy, thermal gradient of the ocean, solar energy, photovoltaic cells, processes of photosynthesis, MHD energy, geothermal energy, and tidal power as energy sources is discussed. (MCW)

SOLAR

REFER ALSO TO CITATION(S) 8137, 8187, 8208, 8211, 8214

GEOTHERMAL

REFER ALSO TO CITATION(S) 8253

OTHER

8614 **Final report on the use of wood as a heat source and the quality of insulation in Vermont households.** Montpelier, VT; State Energy Office (1976). 86p. (NP—22463).

The State of Vermont Energy Office conducted a study to provide the quantitative attitudinal and behavioral information essential to assessing the use of wood as a heat source in the state. General results show that 54% of all home owners in Vermont burn wood to some degree, 47% use wood as a supplementary heat source, 9% use wood as a primary source, and the extent to which wood is used does not differ by geographic area. Results on household uses (cooking and heating) are summarized. A summary of queries on insulation attitudes, awareness, and practices shows that a majority of homeowners believe they have adequate insulation, but are unaware of R factor. In Vermont, about one-fourth of homeowners improved their insulation in the last three years. (MCW)

ENERGY CONVERSION

MHD GENERATORS

REFER ALSO TO CITATION(S) 8613

DESIGN AND DEVELOPMENT

8615 (AD-A—040381) **Study of high power, high performance portable MHD generator power supply systems. Final report 2 Jun 75-Mar 76.** Sonju, O.K.; Teno, J. (Maxwell Labs., Inc., Woburn, Mass. (USA)). Aug 1976. Contract F33615-75-C-2069. 250p. NTIS PC A11/MF A01.

This report presents the results of a study program undertaken to investigate and evaluate high power, lightweight, MHD generator systems. Detailed design studies of various MHD generator systems for use as a prime source in the range of power from 10 to 50 MW operating for some 63 to 120 seconds total run time were performed. Both single and multipulse operations were considered. A relatively wide range of operating parameters were considered and eight specific point designs were investigated. A three-year development program for a lightweight ground based prototype MHD generator system was defined. The design of a high performance, compact MHD generator system involves the consideration and trade-off of a number of the MHD generator operating parameters including the power density, the efficiency, the magnet flux density, the length to diameter ratio of the channel, the channel configuration, the boundary layers, the conductivity, and the various flow parameters. Once compactness and optimization have been achieved in this regard, the matter of lightweight components becomes an important consideration. In the present study, trade-off studies in terms of the operating parameters were conducted, and the designs of lightweight components were studied and evaluated. Lightweight rocket-type combustors, both using solid and liquid

fuels, exist and were evaluated in terms of performance in an MHD generator system. The design of compact, lightweight, superconducting magnets and generator channels were evaluated. A small lightweight MHD channel is currently being fabricated.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 8271

DUCT ENGINEERING AND FLUID DYNAMICS

8616 Cathode spots on metallic electrodes under the conditions of the channel of an MHD generator. Beilis, I.I.; Zalkind, V.I.; Tikhotskii, A.S. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 131-135(Jul 1977).

The article discusses cathode processes of an arc discharge under the conditions of the channel of an MHD generator, a special characteristic of of which is the deposition of a layer of additive on the surface of the metallic electrode. It gives a theoretical description of the above kind of discharge, in accordance with which a spot burns as the result of the vaporization of a previously deposited film of additive, while the temperature of the spot is determined by the thermal conductivity of the metallic cathode. For a copper cathode, the article gives calculations of the radius and the temperature of the spots as a function of the mean temperature of the surface of the electrode, arising as a result of its heating by a stream of hot gas. The results of calculations are in good agreement with the corresponding experimental data.

8617 Acceleration nozzles of MHD generators with deformation of supersonic flow. Efremov, N.M.; Tikhonov, B.A.; Khalkevich, V.A. (I. V. Kurchatov Atomic Energy Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 136-139(Jul 1977).

Results are presented of experimental studies of nozzles having a cross section which is deformed in the supersonic region from a circular section in the critical section to a rectangular one at the nozzle cutoff. The static pressure distributions are given on the wall, in the angle, and along the axis of the nozzle. The coefficients of nonuniformity of the flow are determined in terms of the Mach number and the dynamic pressure loss for the types of nozzles considered.

8618 Effect of flow inhomogeneity on plasma instability near a channel wall. Meitlis, V.P. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 139-142(Jul 1977).

Plasma flow stability is considered near an electrode-free wall of an MHD generator channel. Allowance is made for the effect inhomogeneity of the motion, which influences the devlopment of oscillations.

8619 Two-dimensional analysis of end effects in diagonal type nonequilibrium plasma MHD generator. Ishikawa, M.; Umoto, J. (Kyoto Univ, Inst of At Energy, Jpn). *Mem. Fac. Eng., Kyoto Univ.;* **38**: 182-197(Oct 1976).

In this paper the authors investigate two-dimensionally the influences of the arrangement of the output electrodes and the attenuation of the magnetic induction on the current distribution in the end regions of a diagonal type nonequilibrium plasma MHD generator. As a main result, it is made clear that the eddy current in the ends of the generator can be almost nullified by a proper distribution of the magnetic induction and a suitable arrangement of the output electrodes and that the variety of the dispositions of the output electrodes has little influence on the current distribution. 7 refs.

THERMOELECTRIC GENERATORS

MATERIALS, COMPONENTS, AND AUXILIARIES

8620 Apparatus for measuring the thermal conductivity of thermoelectric materials at high temperatures. Petrov, A.V.; Tsypkina, N.S. (A. F. Ioffe Physicotechnical Institute). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 119-124(Jul 1977).

A procedure for measuring the thermal conductivity of thermoelectric materials at 1100—2000°K is considered; it is based on determining the temperature distribution along the length of a sample heated from one end and radiating freely from its lateral surface. An apparatus suited to this method is described and an analysis of its operation under various conditions is presented. The results of thermal-conductivity measurements carried out on MPG-6 graphite, lanthanum telluride, and two samples of cubic silicon carbide are also given.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 8271

FUEL CELLS

MATERIALS, COMPONENTS, AND AUXILIARIES

8621 (COO/2879—2) **Materials of construction and electrode materials for a fuel cell using a perfluoroalkane sulfonic acid electrolyte. Final report, April 1, 1976—April 30, 1977.** Sarada, T.; Granata, R.D.; Foley, R.T. (American Univ., Washington, D.C.). Apr 1977. Contract EY-76-S-02-2879. 102p. Dep. NTIS, PC A06/MF A01.

Potential materials of construction for use in trifluoromethanesulfonic acid monohydrate and its water solutions were investigated. Corrosion tests, both stationary and under potential, showed that alloys such as ingot iron, chrome steels, Incoloy, tantalum coated steel, and niobium, offered considerable resistance to corrosion in the electrolyte. The monohydrate wets Teflon but water-monohydrate mixtures containing less than 60% of the monohydrate exhibit high contact angles with Teflon. The electrical conductivities of monohydrate-water mixtures were compared to those of sulfuric acid and phosphoric acid. All three systems show a maximum in the conductivity-composition curve with that of the monohydrate-water system falling at 40 to 45% of the monohydrate. A method to measure the vapor pressure of electrolytes was established.

8622 (N—77-24592) **Experimental evaluation of a breadboard heat and product-water removal system for a space-power fuel cell designed with static water removal and evaporative cooling.** Hagedorn, N.H.; Prokipius, P.R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). May 1977. 27p. (NASA-TN-D—8485; E—8822). NTIS PC A03/MF A01.

A test program was conducted to evaluate the design of a heat and product-water removal system to be used with fuel cell having static water removal and evaporative cooling. The program, which was conducted on a breadboard version of the system, provided a general assessment of the design in terms of operational integrity and transient stability. This assessment showed that, on the whole, the concept appears to be inherently sound but that in refining this design, several facets will require additional study. These involve interactions between pressure regulators in the pumping loop that occur when they are not correctly matched and the question of whether an ejector is necessary in the system.

8623 Gels as battery separators for soluable electrode cells. Sheibley, D.W.; Gahn, R.F. US Patent 4,018,971. 19 Apr 1977. 6p.

Gels are formed from silica powders and hydrochloric acid. The gels are then impregnated into a polymeric foam and the resultant sheet material is then used in applications where the transport of chloride ions is desired. Specifically disclosed is the utilization of the sheet in electrically rechargeable redox flow cells which find application in bulk power storage systems.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 8582

8624 Efficiency of obtaining and delivering energy. Loberg, T.J.; Cuccinelli, K.T. (American Gas Association, Arlington, VA). pp 473-492 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The second law of thermodynamics generally deals with thermal efficiency of a heat engine which depends only on the absolute temperatures of the source and the sink. Second law efficiencies are significant in identifying energy utilization efficiency. The efficiencies of the various fuels and energy distribution systems in use in the United States are discussed. After discussing natural gas, coal, petroleum, nuclear fuels, hydroelectric power, and solar energy, it is concluded that the highest efficiencies are realized by utilizing fuels as directly as possible. (MCW)

8625 EEI energy picture: sources, patterns of consumption, and impact. Robart, C.P. Jr. (Edison Electric Inst., New York). pp 462-

467 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The sources of energy in the United States, the major end uses of energy, how the energy is used in the generation of electricity, and its sources are discussed. Also included is a review of energy uses by sectors and by fuels for the various major categories.

BUILDINGS

REFER ALSO TO CITATION(S) 8556, 8565, 8651, 8701, 8702, 8713, 8714

8626 (COO—2883-18) **Demonstration of a high S.P.F. gas heat pump for the north—central United States. Monthly narrative report No. 17.** Swenson, P.F. (Consolidated Natural Gas Service Co., Inc., Columbus, Ohio (USA)). 20 Aug 1977. Contract EY-76-C-02-2883. 81p. Dep. NTIS, PC A05/MF A01.

Progress in studying the cost and market potential of HSPF gas heat pumps of the $7\frac{1}{2}$ ton and larger size level and in testing components of the system is reported. (LCL)

8627 (PB—267167) **NBSLD (National Bureau of Standards Load Determination), the computer program for heating and cooling loads in buildings. Release No. 1. Software.** Kusuda, T.; Barnett, J.P. (National Bureau of Standards, Washington, D.C. (USA). Building Environment Div.). Apr 1977. vp. (NBS-BSS—69-BCD). Bureau of Standards, Washington, DC.

A comprehensive computer program called NBSLD, the National Bureau of Standards Load Determination program, has been developed at NBS to reflect the time change of the many building parameters which are pertinent to accurate estimation of energy usage for heating and cooling. Current status of heating and cooling load techniques is reviewed. Of general interest are unique features of NBSLD which are not available in existing computer programs. A summary of various subroutines of NBSLD is given along with the detailed procedures for them. These subroutines constitute the recommended subroutine algorithms of the ASHRAE Task Group on Energy Requirements. Complete Fortran listing of NBSLD and data preparation forms are given for those who wish to use the program. The NBSLD computation is on the basis of the detailed solution of simultaneous heat balance equations at all the interior surfaces of a room or space. Transient heat conduction through exterior walls and the interior structures is handled by using conduction transfer functions. The use of heat balance equations, although time consuming in calculation, can avoid the vagueness and uncertainties inherent in the more popularly used weighting factor approach. In addition, it is more accurate for a specific building design.The program is written in the FORTRAN programming language for implementation on a UNIVAC 1108 computer using the UNIVAC 1100 Exec 8, version 33, operating system. 250K of core storage are required to operate the program.

8628 (PB—267168) **NBSLD (National Bureau of Standards Load Determination), the computer program for heating and cooling loads in buildings. Release No. 1. Software.** Kusuda, T.; Barnett, J.P. (National Bureau of Standards, Washington, D.C. (USA). Building Environment Div.). Apr 1977. vp. (NBS-BSS—69-ASCII). Bureau of Standards, Washington, DC.

A comprehensive computer program called NBSLD, the National Bureau of Standards Load Determination program, has been developed at NBS to reflect the time change of the many building parameters which are pertinent to accurate estimation of energy usage for heating and cooling. Current status of heating and cooling load techniques is reviewed. Of general interest are unique features of NBSLD which are not available in existing computer programs. A summary of various subroutines of NBSLD is given along with the detailed procedures for them. These subroutines constitute the recommended subroutine algorithms of the ASHRAE Task Group on Energy Requirements. Complete Fortran listing of NBSLD and data preparation forms are given for those who wish to use the program. The NBSLD computation is on the basis of the detailed solution of simultaneous heat balance equations at all the interior surfaces of a room or space. Transient heat conduction through exterior walls and the interior structures is handled by using conduction transfer functions. The use of heat balance equations, although time consuming in calculation, can avoid the vagueness and uncertainties inherent in the more popularly used weighting factor approach. In addition, it is more accurate for a specific building design. The program is written in the FORTRAN programming language for implementation on a UNIVAC 1108 computer using the UNIVAC 1100 Exec 8, version 33, operating system. 250K of core storage are required to operate this program.

8629 (PB—267169) **NBSLD (National Bureau of Standards Load Determination), the computer program for heating and cooling loads in buildings. Final report.** Kususa, T. (National Bureau of Standards, Washington, D.C. (USA). Building Environment Div.). Jul 1976. 406p. (NBS-BSS—69-DOC). NTIS PC A18/MF A01.

A comprehensive computer program called NBSLD, the National Bureau of Standards Load Determination program, has been developed at NBS to reflect the time change of the many building parameters which are pertinent to accurate estimation of energy usage for heating and cooling. Current status of heating and cooling load techniques is reviewed. Of general interest are unique features of NBSLD which are not available in existing computer programs. A summary of various subroutines of NBSLD is given along with the detailed procedures for them. These subroutines constitute the recommended subroutine algorithms of the ASHRAE Task Group on Energy Requirements. Complete Fortran listing of NBSLD and data preparation forms are given for those who wish to use the program. The NBSLD computation is on the basis of the detailed solution of simultaneous heat balance equations at all the interior surfaces of a room or space. Transient heat conduction through exterior walls and the interior structures is handled by using conduction transfer functions. The use of heat balance equations, although time consuming in calculation, can avoid the vagueness and uncertainties inherent in the more popularly used weighting factor approach. In addition, it is more accurate for a specific building design.

8630 **Method of optimization of a "centralized vapor cooling system" in terms of the velocity of the refrigerant.** Melikyan, Z.A.; Margaryan, A.A.; Petrosyan, A.L. (Yerevan Polch Inst im. K. Marks, Arm SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 5, 81-87(May 1977). (In Russian).

A newly proposed centralized cooling system, based on the principle of transporting refrigerant vapors from a center to the consumers and back, is described and a method of its optimization is presented. The optimization is carried out with regard to the velocity of flow of the refrigerant in the feeding and return main pipelines. As a result of an anaysis of theretical data obtained in accordance with this method, simplified formulas are proposed for the determination of the optimal velocity of theoretical gaseous refrigerant in the feeding and return pipelines.

8631 **Criteria for the design and sizing of heat pump heating systems and their economy.** Cube, H.L. von. *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 37-39(Jan 1977). (In German).

In the design and sizing of a heat pump heating system a variety of factors has to be considered if an optimum solution adapted to the specific requirements is to be found. Theses criteria are: application, heat source, heating system, mode of operation, source of secondary heat, type of heat pump, performance, cost and the utilization of primary energy. All these aspects are dealt with from the designer's point of view.

8632 **Meteorological data for space-heating and the use of heat pumps.** Jurksch, G. *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 22-28(Jan 1977). (In German).

8 figs.; 2 tabs.; 5 refs.

There is no doubt that meteorological and climatological data are of considerable use in solving space-heating problems. Users of such data should, however, consider that the territory of the Federal Republic of Germany is situated in a transitional zone from a maritime to a continental climate and that in the central and south German regions highly different local climates occur. This makes the interpretation of climatological data difficult so that detailed specialist knowledge is required for the purpose. Referring to examples for such component as air temperature, relative humidity and enthalpy, climatic peculiarities are discussed.

8633 **Thermal heat pump.** Mostofizadeh, C. *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 35-36(Jan 1977). (In German).

2 figs.; 1 ref.

A new type of thermal heat pump for heating buildings and service water is discussed. The essential feature of this pump is that it is operated with fossil fuels or waste heat at elevated temperature. A hot-fluid injector pump is used as compressor. Its operating principle and essential features are described. The decisive advantage offered by the thermal heat pump is that no secondary heat source and no high supply temperature are required to make up for low outside temperatures. In such cases the boiler can supply the entire heat load.

8634 **Heat sources for heat pump-operation presented in a matrix.** Paul, J. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Lehrstuhl und Inst. fuer Angewandte Thermodynamik und Klima-

technik). *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 40-41(Jan 1977). (In German).

2 figs.; 1 tab.; 1 ref.

Heat-sources which may be applied for heat pump-operation in a matrix are described. The most important criteria for application are listed qualitatively as well as quantitatively.

8635 Compression heat pumps. Reichelt, J. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Lehrstuhl und Inst. fuer Angewandte Thermodynamik und Klimatechnik). *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 29-33(Jan 1977). (In German).

13 figs.; 1 tab.

The components nowadays used in heat pump installations originate from refrigeration engineering. Compared with conventional refrigeration equipment more exacting demands are in most cases imposed on heat pumps in respect to operating cost, control and service life, etc. The heart of the compression heat pump is the compressor. The trunkpiston compressor still dominates the scene for small-capacity heat pumps as used in domestic heating. Its special features are described for the semihermetically and hermetically sealed types. Other types have already been accepted or are still in the process of development. Apart from the compressor, other components such as evaporator, condensor, expansion valve, etc. will also have to be adapted to meet the specific requirements of a heat pump installation depending on heat source and application.

8636 Absorption-heat pumps. Steimle, F. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Lehrstuhl und Inst. fuer Angewandte Thermodynamik und Klimatechnik). *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 34-35(Jan 1977). (In German).

4 figs.

A thermodynamic system is used in absorption-heat pumps which provides compression and is therefore different to mechanical compressors as used in compression-heat pumps. The energy needed for operation is heat of power. The capacity of the absorption-heat pumps can be improved by using heat exchangers in the refrigerant as well as in the solution cycle. As heat is supplied in two heat exchangers both beeing of different temperature it is advantageous to use both heat sources for residence heating and warm water supply. Common absorption-heat pumps are operated with ammonia/water and water/lithiumbromide; other species of refrigerant/solvent combinations are tested these days.

8637 Thermodynamical fundamentals. Steimle, F. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Lehrstuhl und Inst. fuer Angewandte Thermodynamik und Klimatechnik). *Elektrowaerme A Tech. Ausbau.;* **35**: No. 1, 19-21(Jan 1977). (In German).

7 figs.; 1 tab.

According to the use of the cold or warm end of the thermodynamic process in which heat from lower temperature is transported to a higher level, refrigeration- or heat pump-operation is defined. The differences between ideal and real cycles are shown in the common diagrams of properties of the refrigerant. The Coefficient of Performance (COP) is the most important criteria for energetic and economical aspects, other numbers like volumetric heat capacity and the pressure ratio are also important. According to those aspects the most efficient operation and refrigerant can be determined.

8638 Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976). 292p. (CONF-760488—P1).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

Abstracts were prepared for 47 of the 48 papers (in 2 volumes) presented at the Conference; one paper was processed previously. In Volume I, abstracts were prepared for 33 of the 47 papers, with abstracts prepared for the remaining papers appearing in Volume II. Two citations are announced with abstracts only. (MCW)

8639 Engineering overview of system balance and energy conservation. Coad, W.J. (Charles J. R. McClure and Associates, St. Louis). pp 19-21 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

In the study of energy economics relating to energy conversion systems, the first step is to identify the two fundamental components of the analysis, product energy and process energy. The product energy in building systems is that energy required to directly satisfy space environmental needs, in the form needed. The process energy is the energy consumed by the "system" to satisfy the product need. The need for careful initial and ongoing adjustments of the various subsystems and components to achieve minimization of process energy is discussed. All process energy is considered to be energy loss.

8640 System balance procedures as related to energy conservation. Wray, H.L. (Midwest Engineering Service, Inc., Denver). pp 27-31 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Conservation is one obvious means of gaining the needed time until a new energy source can be discovered that will fill the needs and wants for an ever-expanding economic growth in society. Balancing of systems, when properly performed, will result in less energy being consumed by the building as a whole. As a principal in an engineering firm that specializes in testing, adjusting, and balancing of environmental systems for buildings, the author believes energy conservation can only be accomplished if there is an improvement in the quality of the TAB work now being performed. It is pointed out that there is a growing demand for a new second phase of balancing for minimum energy consumption after the building is occupied.

8641 Development of control strategies for the individual building. Kmetzo, J.L. (Rockefeller Center Management Corp., New York). pp 46-51 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The emphasis of the paper is on existing buildings, and concentrates on strategies for using controls rather than the controls themselves. Empirical determination of the characteristics of a building and its occupants is described, with emphasis on an experimental rather than analytical approach. The implementation of experimental control strategies for energy conservation is described, and the importance of being able to readily revise experimental procedures is stressed. This is followed by several detailed examples of the application of these strategies, implemented by both graphical and computer terminal approaches. Two buildings are described in the examples; one having extensive changes in the existing pneumatic controls, the other having a computer based control center. Once the optimum control strategies have been developed, they must be consistently applied. A discussion of the planned use of a custom designed program for a computer-based control center to supplement the manual techniques is presented. The specific example discussed is night heating in a building where design limitations call for a special operating approach.

8642 Energy conservation methods through the use of building automation systems. Shih, J.Y. (Powers Regulator Co., Northbrook, IL). pp 61-69 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The growth of building automation systems has necessitated the use of general purpose computers and microprocessors. Today, the modern automation system's functional capabilities include energy management, fire and security, building management, etc. The most effective energy conservation method in commercial, industrial, and institutional buildings is the use of modern building automation systems. The numerous energy conservation methods are surveyed herein and the impact of ASHRAE Standard 90-75 on each method is discussed.

8643 Electrical demand limiting (EDL) control strategies. Galehouse, D.W. (Automated Construction Technology, Inc., Dayton, OH). pp 70-76 of In Proceedings of the conference on improving

efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Electrical Demand Limiting (EDL) is the process of monitoring and controlling instantaneous demand requirements thereby spreading the use of electrical energy out to avoid unnecessary peak demand charges. From the consumer's point of view, electrical demand limiting can significantly decrease operating costs and from the utility's point of view, EDL has the potential of significantly reducing future capital expenditures for generating capacity and distribution systems. The results of a study to determine the impact of the various EDL methods on the cost of electrical energy at Wright State University are reported. (MCW)

8644 Method of simulating the performance of a pebble-bed thermal energy storage and recovery system. Mumma, S.A.; Marvin, W.C. (Ohio State Univ., Columbus). pp 126-136 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

A stable, accurate, and inexpensive computer technique for predicting the dynamic behavior of a pebble-bed energy storage subsystem for residential and commercial structures is the thrust of this work. Pebble bed storage subsystems have been suggested and have received some limited application in conjunction with solar collectors, and as a means of load management for the electric utilities. The solution to the transient problem is based upon a one-dimensional heat-transfer model. Existing methods for simulating the transient behavior of pebble beds can be found in the literature. The method currently most frequently cited is the Duffie model. For the sake of comparison, the Duffie model was computer programmed to provide a means of direct comparison with the model proposed in this paper.

8645 Use of thermal capacitance modeling to evaluate heating and cooling loads. Sams, G.W.; Rojeski, P. (Univ. of Tulsa, OK). pp 137-143 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The usefulness of thermal capacitance models for the design of HVAC systems was examined by developing a computer simulation program. This program provided temperatures and thermal heat flux through an idealized wall section under various climate conditions. The idealization of a thermal barrier as finite mass elements requires the use of numerical integration methods. Three integration methods are briefly described to provide the HVAC engineer and building architect an insight to the problems encountered with simulation modelling. The integration methods: explicit Euler, implicit Euler, and implicit Newton were chosen as representative of the methods available. Simulation of an existing building was performed with the implicit Newton method. The conclusion is made that systems and controls designed using thermal capacitance models will be smaller in size and therefore energy conservative. A further conclusion is made that proper controls within a building can reduce the operating time of HVAC equipment while still maintaining a desired comfort condition.

8646 Background, progress, and state-of-the art in applying life-cycle concepts in buildings and systems. Rosoff, D. (Department of Housing and Urban Development, Washington, DC). pp 145-147 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Life-Cycle Costing (LCC) is now effectively applied to all major government acquisitions. The General Accounting Office recommends that a LCC methodology be established and supported among health and maintenance facilities. The General Services Administration has a study of LCC directed toward Federal Office Buildings constructed by PBS. It is apparent that Life-Cycle Costing requires a careful, systematic blending of real world experiences in facility planning and development, building system economics, estimating and costing, energy conservation and economics, data system development, and building operation and management. The main objective of the ongoing studies is to develop life-cycle analytical methodology, produce practical implementation methods and working loads, establish a data bank, and identify incentives to use LCC as an aid in the decision-making process. The elements of Life-Cycle costing fall broadly, into two separate processes, i.e., development and operations.

8647 Life-cycle costing and the General Services Administration. Gerstenzang, N. pp 148-152 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The General Services Administration provides other agencies with their working supplies and services, ranging from pencils to automobiles. GSA's Public Buildings Service (PBS) acquires, constructs, operates, and maintains real property for use of the Federal establishment. GSA's real property activities are vested in the Public Buildings Service. PBS houses 800,000 Federal employees in 225 million square feet of space in 10,000 buildings throughout the United States. Of the total, 150 million square feet comprise Government-owned space and 75 million square feet in 6,000 buildings comprise leased space. Extension of the above data indicates GSA's interest in life-cycle cost treatment of its buildings. For example, support of our 150 million square feet of space consumed approximately $1\frac{1}{3}$ million tons of structural steel, or approximately 1 percent of the nation's annual steel ingot production in 1970. Associated with the large scale consumption of materials in the initial stage is the expenditure of other resources such as labor, time and money to provide the occupiable, operative finished facility. As these valuable resources are consumed, GSA must ask if the best job to utilize national resources in the most efficient manner possible is being done. The method for a life-cycle cost analysis is described. (MCW)

8648 Pros and cons of life-cycle costing. Patterson, N.R. (Trane Co., La Crosse, WI). pp 153-157 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Energy management and the hard job the energy manager has are discussed. The advantages of life-cycle costing are summarized. Life-cycle costing will save energy, will have a significant effect on the air conditioning industry, will encourage new development and a higher degree of excellence in the technological backup requirements of industry, and will clearly point out the best balance between first cost and owning and operating costs which include energy costs. The private sector is dragging its feet on the use of LCC. (MCW)

8649 Mystery of future energy prices. Guntermann, A.E. pp 170-179 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The future cost of energy is the mystery variable in evaluating building energy systems. The purpose of this paper is to develop an appreciation for the effect of future energy costs on life-cycle costing; and perhaps to arrive at some conclusions that may be the basis for refinement and future improvement by others. Because of the large number of variables affecting energy costs, i.e., fuel scarcity, interest rates, inflation, and manpower requirements; it is valid to ask whether anyone can accurately forecast prices. But an analysis of

the energy crisis from the standpoint of energy prices offers some interesting insights. For example, energy conservation lowers the future cost of energy.

8650 Designing duct systems for minimum life-cycle cost. Stoecker, W.F.; Bertschi, R.L. (Univ. of Illinois, Urbana). pp 200-207 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The design of duct systems by traditional design procedures such as velocity reduction, equal friction, and static regain results in workable systems but not necessarily optimal ones. A computer is described that selects the combination of fan total pressure and duct diameters which result in the optimal life-cycle cost. The required input includes: (1) the geometrical layout, (2) air flow rates at each outlet, (3) pressure drops through filters, coils, and outlets, (4) velocity restrictions, (5) fan input power, (6) cost of electrical energy, and (7) cost of ductwork per unit mass. The program computes the sum of the duct cost and the present worth of the operating cost as a function of the fan total pressure, thus enabling selection of the most economical system. The duct sizes and the fan total pressure specified by the computer program is the combination resulting in the lowest life-cycle cost. The system so designed is virtually in balance without resort to dampering.

8651 Integrated life-cycle cost and energy model. Meckler, G.; Lokmanhekim, M. (Gershon Meckler Associates, Washington, DC). pp 208-213 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Life-cycle cost models and energy models applied independently may very well indicate contrary courses of action during the evaluation of alternatives. However, by using interacting trade-off equations which are based on the First and Second Law of Thermodynamics, in both the energy and the life-cycle cost models, one can generate alternative designs which will optimize the use of energy, the use of money, and the operation of a building. Thus, the integrated life-cycle cost and energy model developed evaluates the efficient performance of a building. This procedure establishes a rational methodology for bringing capital cost versus total cost trade-offs to bear on the design and choice of energy efficient systems and components in the design and construction of buildings. Using this procedure, interactions of different energy utilizing system elements of a building can be analyzed in order to compare various design alternatives. This will establish the economic significance of the various trade-off opportunities possible to achieve optimum performance, energy use efficiency, and energy conservation at a minimum life-cycle cost.

8652 Non-computerized rational energy analysis procedure. Treichler, W.W. (Carrier Corp., Syracuse, NY). pp 214-224 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Computer programs have shown their value for building HVAC energy analyses, but there are certain situations where a non-computerized procedure may be used to advantage. These include: where computer access is difficult, expensive, or turnaround time is excessive; when the user does not agree with assumptions programmed into a computer program; where the computer program is not sufficiently definitive for some phase of the analysis; as a check procedure for a computerized analysis program; and for training in HVAC system evaluation. The Machinery and Systems Division of Carrier Corporation developed a Rational Energy Analysis Procedure (REAP) designed as viable alternative to computerized energy analysis procedures. The primary objective of REAP was to provide a rational method for comparing energy consumption of an existing building with an existing HVAC system if suitable adjustments are made to allow for the imperfections in system operation, unpredictability of outside air infiltration, and possible equipment deficiencies.

8653 Manual calculation methodology to predict energy savings for HVAC system operational modifications. Ross, H.D. (Ohio State Univ., Columbus). pp 225-236 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Some manual methods that engineers may use to evaluate some of the energy conservation techniques regarding existing HVAC systems are discussed. Manual calculations are preferred since it has been reported that computer simulations sometimes vary as much as 40 percent with each other in space loads. A manual calculation method to predict changes in energy consumption as a result of HVAC system operational changes has been developed at Ohio State University. Equations have been established that have as their components a large number of parameters that affect energy consumption and that may be modified when retrofitting an existing building and system. Environmental calculations were performed for laboratories and office buildings on the university campus. In summary, the methodology appears to be valid for a number of common HVAC system modifications. Some non-steady state modifications such as heat recovery, enthalpy control, and electric load shedding seem to be beyond the capacity of the method. (MCW)

8654 Estimating energy usage in building HVAC systems using the AXCESS-UMR energy analysis computer program. Howell, R.H.; Sauer, H.J. Jr. (Univ. of Missouri, Rolla). pp 237-247 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The EEI-AXCESS Program can be used for estimating energy requirements of various types of environmental control (HVAC) systems. The AXCESS Program was designed for making comparisons of the energy requirements of HVAC systems when the building is in the design stage and simulates the operation of various types of terminal and primary systems planned for installation in large buildings by making hourly calculations using weather data and building specifications. The program may also be used to evaluate various energy conservation techniques for HVAC systems in existing buildings. This program offers the designer and the owner a means of comparing possible HVAC systems from the financial aspect as well as the energy efficiency aspect. Energy requirements for a two-story all-electric office building for the existing design and operating configuration were found for four years (1970-1973 for St. Louis, Missouri). Various energy conservation measures (set point temperatures, cold deck temperatures, economizer cycle, etc.) were simulated and compared to the design configuration.

8655 Fan controls for variable-air-volume systems. Cooper, K.W. (Borg-Warner Corp., York, PA). pp 272-281 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Variable air volume systems minimize energy usage while maintaining good space temperature control. The fans employed in these systems must operate over a wide range of flow rates. Some means of controlling the fan outlet static pressure is required. Two control methods are commonly used: fan outlet dampers and inlet guide vanes with constant speed motors. A variable frequency-variable speed motor drive may also be used. A method of estimating yearly power usage for a typical central station fan coil unit is presented. An economic comparison between the control methods is done on a life cycle basis.

8656 Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976). 524p. (CONF-760488—P2).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

Abstracts were prepared for 47 of the 48 papers (in 2 volumes) presented at the conference. One paper has been previously abstracted for the data bases. Volume II contains 15 papers including a keynote address. A separate abstract was prepared for each paper. Two papers are announced with abstracts only. (MCW)

8657 Energy conservation through improved control strategies. Sinnamohideen, K.; Janisse, N. (Johnson Controls, Inc., Milwaukee). pp 361-372 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

HVAC systems are usually designed for peak load conditions, however, they operate at part load conditions for a major portion of their operating life. Under these part load conditions most systems consume more energy than required to meet load conditions. These inefficiencies can be eliminated to a considerable extent by the improvement of control strategies. This usually means that more variables need to be sensed and/or more complicated control apparatus need to be involved to effect the improvement in the efficiency of these systems. The present generation of central monitoring systems which are incorporated in most of the large scale customized systems offer a great potential for instituting these improved control methods. Hardware and/or software modules available from the control manufacturer that can be expected to achieve energy conservation in the HVAC systems on a cost-effective basis are discussed. The emphasis is on actual job experiences with data given for several projects where control improvements were employed. The rational basis for the control strategy and estimates of the annual savings are outlined. These experiences show that the savings are considerable and moreover economically justified in most cases.

8658 Improved efficiency of oil-fired heating units: minimizing off-cycle losses. Turner, D.W.; Holmes, R.E.; Coburn, J.F. (Exxon Research and Engineering Co., Linden, NJ). pp 378-385 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

During the past two heating seasons (1973-74, 1974-75), a research program was conducted to improve the efficiency of oil-fired heating units. The emphasis of this program was to minimize off-cycle or downtime losses through optimization of the firing rates. At the October 7, 1974 ASHRAE/NBS Cosponsored Energy Conference, the initial data were reported indicating a 7.5 percent fuel savings through optimization of firing rates. During the 1974-75 heating season, a research test and field trial were conducted. The test was conducted to verify the savings measured during the previous heating season. The field trial had three objectives: (1) develop implementation procedures, (2) measure improved efficiency, and (3) evaluate customer reaction. Both the research test and field trial verified the fuel savings reported earlier. The number of each unit type (hot water, warm air, steam) tested was controlled to conform to the field distribution. Data were also accumulated and analyzed as to the steady state efficiencies of field oil-fired units. The experience, limitation, and efficiency improvement of the optimized firing rate technique are discussed.

8659 RIF approach to fuel and energy selection. Jones, R.R. (Department of Commerce, Washington, DC). pp 468-472 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

One of the prime purposes of energy conservation is to optimize our use of non-renewable resources. Present guidelines such as ASHRAE Standard 90-75 address energy conservation within buildings but do not provide a methodology to minimize consumption of resources. It is the intent of proposed Section 12 of ASHRAE Standard 90-75 to provide a method for calculating and reporting the annual fuel and energy resources required to meet the needs of a building project. Further, it is the intent of the proposed Section 12 to provide a means whereby the impact of social, environmental, institutional and economic factors may be incorporated into the fuel and energy selection process. This intent was reflected into the proposed Section 12 (as published in the ASHRAE Journal, July 1975) only by a footnote to paragraph 12.4.7 referring to Resource Impact Factors (RIF). The RIF Concept will be developed as one approach to addressing the complex considerations of the resource value of energy sources.

8660 Energy recovery lowers operating costs. Air conditioning of indoor swimming pools. Arendt, C. *Schwimmbad Sauna.;* No. 32, 28-32(1975). (In German).

7 figs.

Methods to save energy in indoor swimming pools are reported. Heat pumps as well as recuperative or regenerative heat exchangers are suitable for this task. Investment and operational costs are compared. The cost depends on the number of hours of operation and on the expenditure for servicing and maintenance.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 8039, 8614, 8678, 8685

8661 (PB—268132) Government-supported residential rehabilitation. Final report. McFarland, M.C. (National Bureau of Standards, Washington, D.C. (USA)). Jun 1977. Contract NBS-S-315688-73. 60p. NTIS PC A04/MF A01.

The NBS is developing new research to determine how best to remodel and rehabilitate existing buildings as a way of conserving the Nation's resources. As background information, this report discusses the three major programs in residential rehabilitation which HUD has conducted in the past. The programs, whose needs, history, examples, and outcomes are discussed, are urban renewal rehabilitation, concentrated code enforcement, and project rehabilitation. The author was an economist at HUD when these programs were conceived and carried out, and was involved with them either directly or indirectly.

8662 Energy cost reduction for apartment owners and managers. Chicago; Institute of Real Estate Management (1977). 63p. (NP—22618). Energy Administration, Washington, DC $3.00.

A joint study with the Federal Energy Administration.

The apartment owner/manager can deal with rising energy costs by investing in measures to reduce energy consumption. This handbook describes in detail: what major opportunities exist for energy cost reduction, why these recommendations need immediate attention, how these recommendations save money, and how much will it cost now and how much can be saved in the future. Detailed energy audits were performed of energy usages in apartment buildings nationwide. (MCW)

8663 Prefabricated-house manufacturer offers ground heat heating system at a fixed price. *Bauen Fertighaus.;* **14**: No. 71, 110-114(1976). (In German).

7 figs.

A central heating system is described for a prefabricated house. Warm water is used in radiators or in coils in the floor. The water is heated in an lkW electric heat pump with a heating power of about 5 kW. On particularly cold days, automatic switching to a fuel-fired heat generator is included. In peak load hours, the pump is switched off and the heating boiler automaticaly goes into action. Using this regulation, a miniized electricity rate is obtained. The warm water supply is heated in an electrostorer with heating to 5°C in the weak load period. Copper pipe coils are buried in the earth at a depth of 1.50 m. No excavation is required with the use of a ground-displacement device. 700 m of copper piping were used for a living area of —220 ². The high investment costs are balanced by low operational costs in from five to ten years.

8664 Design optimization of air-conditioning systems. Gluck, R.; Pollak, E. (Israel Inst. of Tech., Haifa). pp 36-45 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The paper describes an analytical tool (a digital computer program) developed to facilitate the synthesis of air conditioning system components to minimize energy expenditure for a given cooling capacity. The synthesis is performed by allowing the variation of component properties within a system and the introduction of new components into unique systems. To assure the practical applicability of the developed algorithm, the system components are

selected entirely from production series of various manufacturers. The components' models appear in the form of algebraic functions, typically for the measured through variables (heat and mass transfer) in terms of the measured cross variables (pressure and temperatures). In addition to describing the computer program as a whole, the paper includes a detailed example showing how the optimization procedure was applied to an existing design of a central air conditioning system. The cost saving accrued by the optimized design, compared to the existing one, is also discussed.

8665 Energy conservation with a residential zoning system. Tobias, J.R. pp 77-80 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

A hybrid computer was used to simulate a three zone gas forced air system in a two bedroom rambler. The zoning system could be run with its dampers normally open or normally closed. It was found that the normally open damper system could not maintain as wide a temperature difference between zones as a normally closed damper system when the zone thermostat setpoints were set far apart. In other words, the normally open damper system cannot cut the heat loss from the structure as well as a normally closed damper system can, but the normally open scheme could save fuel because of the small effect it has on furnace efficiency.

8666 Seasonal energy reduction through use of dual-compressor systems. LaFrance, L.J.; Newton, A.B. (New Mexico State Univ., University Park). pp 265-270 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The typical relationships between load and outdoor ambient for residential and small commercial buildings, including the number of hours per season during which a given load level and ambient coexist are considered. The capacity and energy requirements for several combinations of caponents at each load and ambient condition are examined. These factors are weighted by the seasonal hours of operation to derive a seasonal Energy Efficiency Ratio for each system. The analysis includes the conventional system, a modified system with two compressors which may be operated singly or together on the full heat transfer system, and a system with a compressor having fully modulated capacity to always match the instantaneous load requirements of the building. The analysis shows that the dual compressor system can provide nearly the improvement in seasonal EER that can be obtained by infinite modulation, and hence may be more attractive for early use due to its lower development cost.

8667 Off-design performance of a gas furnace. White, R.R.; Goldschmidt, V.W. (Purdue Univ., Lafayette, IN). pp 347-357 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The partload (field) performance of a gas furnace is presented. It was measured as part of a separate study dealing with performance of HVAC Systems in Mobile Homes. The corresponding cyclic efficiency is now compared to the steady state efficiency indicating a corresponding decrease in performance. These measurements can provide the necessary basis to determine seasonal efficiencies and compare them to the load and extent of over-sizing. In the particular case of the furnace now reported, the average seasonal efficiency is in the order of 52 percent. The measureable drop in performance from the steady state efficiency of about 70 percent is attributed to oversizing and the resulting decrease in the cyclic efficiency.

8668 Electric thermal storage systems. Robart, C.P. Jr. (Edison Electric Inst., New York). pp 414-419 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The only major heat storage project involving 20 or more dwelling units that have been operating for over a year is by Central Vermont Public Service. Several other utilities either have or about to file off-peak type of rates so they can begin the promotion of storage type systems. Some heat storage schemes are briefly reviewed that supply 100 percent of the heating and/or cooling requirements of a structure. Partial systems are in use in Europe but are not applicable for U.S. needs.

8669 Pulse combustion: an efficient, forced-air, space-heating system. Hollowell, G.T. (American Gas Association Labs., Cleveland). pp 496-503 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The advantages of utilizing pulse combustion in a residential heating system are discussed. The advantages include powered venting driven by the combustion process and better heat transfer. The powered vented system makes it possible to utilize outside air directly for combustion and to vent directly outside. The need for the draft hood and chimney associated with conventional space heating appliances is eliminated. The improved heat transfer not only makes it possible to achieve thermal efficiencies in excess of 90 percent, but also can lead to reduced overall size of the appliance. Both of these heat transfer advantages can reduce cost of manufacturing a high efficiency furnace. An experimental 100,000 Btu/h downflow residential forced air furnace was designed and constructed. The unit readily fits within the jacket size of a contemporary forced air furnace of equivalent input. Thermal efficiency of the unit during steady state test conditions is 95 to 98 percent with a flue gas temperature below 100°F. Operating variables, component construction leading to the design of the experimental furnace and efficiency test performance are evaluated as they affect test thermal efficiency as well as seasonal efficiency. A problem with the pulse combustion system is combustion system noise. The paper describes methods which have been used in the past and studies currently in progress aimed at noise reduction. As an indication of the potential of the pulse combustion forced air furnace, data and information available on pulse combustion boiler residential hot water space heating systems which have been operating in two Canadian cities since the late 1950's are presented.

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 8683, 8686, 8687

8670 Dynamic simulation analysis of alternative control and operating strategies for a typical office building. Shavit, G.; Spethmann, D. (Honeywell Inc., Arlington Heights, IL). pp 52-59 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

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See CONF-760488—P1.

A detailed description of a building simulation program that takes into account all of the control systems is presented. A block diagram of such a system is provided. The program provides a dynamic simulation of the building, mechanical system, and the controls. The computations of building load, energy requirement by each mechanical system as function of the control system, and the total energy consumption are done every minute. It is used to study the performance of control systems and algorithms for energy conservation. (MCW)

8671 Determination of combined air exfiltration and ventilation rates in a nine-story office building. Kelnhofer, W.J.; Hunt, C.M.; Didion, D.A. pp 322-328 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The sulfur hexaflouride tracer gas technique, which has been used previously for determining air infiltration rates in residential buildings was applied to a nine-story office building of modern design. The building has sealed windows with openings only on the first level and on the roof, and is mechanically ventilated with a variable air volume system. Tests were run during the cooling season by introducing the tracer gas into the main trunk of the air supply system and measuring the concentration decay rate in the return air. Infiltration rates were determined with outside air vents open and closed. To check the results, a second independent method was used, which involved direct measurement and calculation of infiltration rates.

8672 **Self-balancing system saves energy.** Laube, H.L. pp 504-507 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The objective is to show that a self-balancing system for a large high-rise multi-room structure such as an apartment house, a hospital, a hotel or an office building requires less energy than conventional systems that require balancing. The fluid system is the key connection between the air-conditioning load and conventional heating and cooling equipment. Proportioning flows within the fluid system—air, water or both—is what is known as "balancing." The larger the conventional system, the greater the need for balancing. Conversely, the smaller the system, the less this need. Finally, when a completely self-contained heating and cooling mechanism serves only one small space, the need for balancing is entirely eliminated. Thus, when an entire building is served by a multiplicity of such mechanisms—whether individually or centrally controlled—it may be said to have a self-balancing comfort system. The advantages and disadvantages of systems that require balancing are discussed. To complete the picture there follows a brief look into the availability and costs of various energy sources—past, present and future—and how present trends must inevitably influence system design.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 8578, 8672

8673 (AD-A—040256) **A preliminary thermographic heat survey of ARRADCOM facilities (Dover, NJ). Technical report.** Kisatsky, P.; Barbarisi, M.; Tirellis, G. (Army Armament Research and Development Command, Dover, N.J. (USA). Large Caliber Weapon Systems Lab.). Apr 1977. 43p. (ARLCD-TR—77014). NTIS PC A03/MF A01.

An infrared thermographic survey was made of buildings and facilities in Picatinny Arsenal. The purpose of the survey was to demonstrate the usefulness of IR thermography as a diagnostic technique to discover and identify sources of heat loss. Several examples are shown in which thermography yields valuable information on insulation deficiencies, poorly insulated steam lines, running vent fans, open windows, etc. It is shown that thermographic data needs careful interpretation and is vulnerable to emissivity variations. Parameters for developing a quantitative thermographic methodology are identified as a basis for future work.

8674 (AD-A—041235) **Development of methodology for the determination of R values of existing structures by nonsteady-state heat-transfer measurements. Final report, 1 May—30 Jun 1976.** Poppendiek, H.F.; Connelly, D.J.; Fowler, E.W. Jr; Boughton, E.M. (Geoscience Ltd., Solana Beach, Calif. (USA)). Jun 1976. Contract N62583-76-M-W928. 27p. (GLR—171). NTIS PC A03/MF A01.

Energy conservation surveys of Navy facilities often require data on in-place R-values of existing structures. Such information has been difficult to obtain due to transient conditions caused by day-and-night temperature changes. This study indicates R-values can be calculated within about a 6% accuracy from heat flux and inside-outside wall surface temperature data that have been integrated over a 24-hour period.

8675 (N—77-21518) **Application of remote thermal scanning to the NASA energy conservation program.** Bowman, R.L.; Jack, J.R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jan 1977. 25p. (NASA-TM-X—73570; E—9017). NTIS PC A02/MF A01.

Airborne thermal scans of all NASA centers were made during 1975 and 1976. The remotely sensed data were used to identify a variety of heat losses, including those from building roofs and central heating system distribution lines. Thermal imagery from several NASA centers is presented to demonstrate the capability of detecting these heat losses remotely. Many heat loss areas located by the scan data were verified by ground surveys. At this point, at least for such energy-intensive areas, thermal scanning is an excellent means of detecting many possible energy losses.

8676 (PB—268555) **Low energy utilization school, energy conservation operation manual, phase 2: Report.** Stein, R.G.; Stein, C.; Nathan, D.B. (Stein (Richard G.) and Partners, New York (USA)). 31 Mar 1977. 85p. NTIS PC A05/MF A01.

This manual consolidates maintenance and operational steps which will result in the lowest energy use consistent with a schools' educational program. It covers guidelines for maintenance and operating procedures for energy efficiency in the plant, a revised set of standards based on extensive research, and methods of scheduling and controlling the use of the equipment to provide services only when the spaces are occupied and only to the extent required by physical conditions and types of activity. Mainly, the discussion concerns procedures that are the custodian's responsibility.

8677 **Thermal energy storage and recovery experiences with a typical elementary school.** Barnard, D.M.; Harman, W.S. (Consulting Engineers, Barnard and Maybeck, Rochester, NY). pp 110-116 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Any building project has the potential for advantageously using thermal storage. In one case, excess heat available during occupied hours may be recovered and stored for use in maintaining building heat balances during unoccupied hours. In another, hot and chilled water generating equipment may be reduced in size and heated or cooled water can be generated and stored for use for peak shaving during periods of greatest loads. In both cases a system of heat recovery is necessary to collect and share excess energy. The results obtained for an elementary school building using an internal source heat pump system with thermal storage in the form of water are presented. The school is built as a standard operating unit of the City School District, Rochester, New York.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 8581, 8666, 8672

8678 (PB—268409) **Energy management for texas commerce and industry.** Jones, J.; Bywaters, R.; Schmidt, P. (Texas Univ., Austin (USA). Center for Energy Studies). 1976. 169p. copies only.

The following topics are discussed: need for energy planning; basic ingredients of an energy management program; energy conservation in buildings; energy conservation in industry and manufacturing; and management of energy resources.

8679 **Combined roof and recessed light loads with ceiling insulation and ventilation.** McMenamin, D.L. (Altemose Architects and Engineers Assoc., Center Square, PA). pp 2-11 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Design criteria for room gains from combined roof and recessed light loads have been developed at length in Chapter 3 of the 1973 ASHRAE Systems Handbook. However, the treatment is limited primarily to cases where the roof-ceiling space is used either as a supply or return plenum. The conclusion is drawn that, if the plenum is inactive, "the light heat is 100% chargeable to the room regardless of any portion which might be directly emitted to the dead ceiling plenum." This conclusion is based on a condition in which the roof is heavily insulated compared to the ceiling and, in fact, is correct only when that condition obtains. ASHRAE research on recessed non-air handling light fixtures indicates that approximately 55% of the input light heat is emitted to the plenum at a plenum temperature of 100°F, and it is the intention herein to present a design criterion which takes maximum advantage of this

knowledge. In this paper the interstitial space (plenum) between roof and ceiling is examined under steady state heat transfer from the roof, ceiling, ductwork, recessed non-air handling light fixtures and convection transfer by ventilation. The average interstitial space air temperature is determined from a heat balance. The combined room gains due to the ceiling, lights, and ductwork are obtained in terms of: the room, sol-air, ventilation air and duct air temperatures; roof, ceiling and ductwork areas and "U" factors; ventilation rate; the total light heat and the fraction thereof emitted to the plenum. The effects of the various parameters are described and discussed. The technique is employed in the design of a medical research facility for the Emergency Care Research Institute.

8680 Testing building environmental systems for energy conservation programs. Gupton, G.W. Jr. (Partner, Peters-Gupton and Associates Consulting Engineers, Atlanta). pp 12-17 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

An overall energy conservation program that has evolved at Gupton Engineering Associates is outlined. Five principal phases include surveys; a reduction of basic loads; optimization of building systems; control operation of building systems; and maintenance of systems in optimum operating modes. The importance of test systems, observations, and planning are stressed. (MCW)

8681 Effect of reducing excess firing rate on the seasonal efficiency of 26 Boston oil-fired heating systems. Bonne, U. (Honeywell Corporate Research Center, Bloomington, MN); Katzman, L.; Kelly, G.E. pp 81-93 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Dynamic performance data of oil-fired heating systems were gathered in a recent field study, and were analyzed with the help of a digital heating system simulation model to determine: (1) seasonal systems fuel utilization efficiencies; (2) efficiency increases and fuel savings achievable by reducing excess burner firing rate (nozzle size); and (3) major system energy losses and means to reduce them. A total of 39 systems were analyzed. For 26 of them field data were obtained and the analysis was made for conditions before and after the firing rate was reduced by an average of 27 percent. Of these systems, 6 used forced warm air, 16 hot water, and 4 steam as heat transfer fluid. The average seasonal efficiencies before and after reduction, and the weighted fuel and operating cost savings derived with the data and the simulation model were, for the three types of heating systems are tabulated. Relative standard derivations were derived for all the computed data.

8682 Heat storage with use of centrifugal refrigeration machines and evaporative coolers. Filson, F.E. (Filson-Minnich and Associates, Inc., Harrisburg, PA). pp 95-98 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Much of the electrical energy requirements needed today to heat the interior core areas of commercial buildings is being wasted to the atmosphere after being used, only once, to produce the chilled water requirements for the air conditioning systems for these areas. It is possible, with a properly designed and shaped building, to utilize most of the electrical energy delivered to the building, convert it to heat, and heat the building during the heating season without adding supplementary heat. To accomplish this, underground hot water storage tanks are being used to store this heat with "on peak" heat release within the buildings, storing this heat in these underground water storage tanks and utilizing this to heat the building in the "off peak" hours. Air conditioning systems utilizing waste heat for heating, from the condenser sections of refrigeration compressors, have been in existence for many years, but have ignored the potential for the storage of this excess heat. The system performance is described with a sequence of operation of such a system followed.

8683 Screw compressor system. Shaw, D.N. (Dunham-Bush, Inc., West Hartford, CT). pp 99-109 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The system discussed is installed and operating in the Dunham-Bush corporate headquarters building in West Hartford, Connecticut. The system utilizes heat recovery from the Engineering Laboratory, heat storage through a large water tank, and heat pickup from an air source evaporator. A hermetic screw compressor is utilized which in turn delivers heat into an existing hot water heating system. Generated hot water temperature rises as the ambient drops and reaches 150°F max at -10°F ambient. It is shown that this system eliminates the necessity for oil usage in the building. Yearly oil usage for heating and reheat purposes was 29,000 gallons per year. At a current rate of $.3625 per gallon, this amounted to $10,512 per year. The heat pump/heat reclaim system will consume 155,000 KWH considering all heating requirements as well as reheat requirements. This will amount to a total of $5565 per year based on current KWH rate of $.0359. With this new system, the reheat is free. Heat that is removed from a relatively warm zone will merely be transferred to those zones that tend to run cooler.

8684 Method for calculating commercial seasonal performance factors. Erlandson, C.W. (General Electric Co., Louisville, KY). pp 248-261 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

Estimating the theoretical seasonal energy requirement of a conventional heating system (gas furnace, oil furnace, electrical furnace, etc.) using the degree day method is relatively simple because the efficiency of the system is assumed to be constant regardless of outdoor temperature. The calculations for the annual theoretical heating requirements for these conventional systems are shown. The calculations for heat pump are not so simple, since the efficiency of the heat pump changes with the outdoor temperature. The climatic efficiency of a heat pump system is usually expressed as a Seasonal Performance Factor. In calculating Seasonal Performance Factors (SPF) U.S. Government weather information is used to determine the number of hours per year that fall within each 5°F temperature bin in a given area. The formula for calculating SPF is shown for residential and commercial buildings. (MCW)

8685 Energy conservation programs for consumer products. Owens, W. (Federal Energy Administration, Washington, DC). pp 287-293 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The responsibilities of the Federal Energy Administration on the legislation (PL 94-163) to develop appropriate test procedures and develop energy efficiency improvement targets, specifically for HVAC systems and home appliances are discussed. Congress did not dictate any specific variables with which to deal, so FEA and the National Bureau of Standards are working closely with members of the industry to specifically set energy efficiency standards. (MCW)

8686 Feasibility of energy use indices and their use: a status report. Back, P.P.; Hayes, P. (Federal Energy Administration, Washington, DC). pp 295-309 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

An overview of the utility of energy use indexes (EUIs) is presented and several attempts at developing EUI estimating rela-

tionships for commercial office buildings are reviewed. Although data quality contributed to the less than desirable results, it was felt that the brute force approach employed in these attempts would not yield acceptable estimating equations even if data quality and sample size increased. For this reason, a functional energy accounting model formulation was developed to estimate total building energy consumption. The rationale being that one should first test a model of how energy is consumed for a building so as to be able to reliably estimate total energy consumption, then transform such estimates into an index form. Using the same data, estimating equations were developed; however, their predictive accuracy, although greater than previous efforts, was less than expected. Model form and data quality are felt to be the major contributors to the low predictive power of the developed equations. Using the estimated data, direct reductions to index forms were undertaken and correlations with observed data made.

8687 **Limitations on cycled operation of air-conditioning equipment.** Mason, T. (B.F. Goodrich Co., Akron, OH). pp 310-318 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The principles involved in Energy Management Systems, as recently proposed to The B.F. Goodrich Company by Honeywell, IBM, and others are described. Documented opinions of vendors of HVAC and auxiliary equipment were solicited as to the effects of Energy Management cycling upon their devices. A test was performed, using this principle, to control air-handling fans serving the project engineering drafting area and several managers' offices. Electrical usage was closely monitored, and the results incorporated into cost and payback calculations. Discomfort was noted and savings did not match calculations. Conservative installation and maintenance estimates were made.

TRANSPORTATION

REFER ALSO TO CITATION(S) 8579

AIR AND AEROSPACE

REFER ALSO TO CITATION(S) 8750, 8759

8688 (N—77-21087) **A preliminary study of the use of intercooling and reheat in conjunction with regeneration for aircraft turbine engines.** Eisenberg, J.D. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Mar 1977. 39p. (NASA-TM-X—73617; E—9106). NTIS PC A03/MF A01.

The effect on fuel consumption of turbofans with intercooled, regenerative cycles and with intercooled, regenerative, reheat cycles was studied. The technology level for both engine and aircraft was that projected for 1985. The simulated mission was a 5556 km flight carrying 200 passengers at Mach 0.8 at 11582 min. Results indicate that these relatively complex cycles offer little, if any, fuel savings potential relative to a conventional turbofan cycle of comparable advanced technology. The intercooled, regenerative cycle yields about the same fuel economy as a conventional cycle at close to the same overall pressure ratio.

8689 (N—77-23007) **Examination of the costs, benefits and energy conservation aspects of the NASA aircraft fuel conservation technology program.** (Ultrasystems, Inc., Irvine, Calif. (USA)). 15 Nov 1975. Contract NASW-2859. 66p. (NASA-CR—152683; REPT—8291-01). NTIS PC A04/MF A01.

The costs and benefits of the NASA Aircraft Fuel Conservation Technology Program are discussed. Consideration is given to a present worth analysis of the planned program expenditures, an examination of the fuel savings to be obtained by the year 2005 and the worth of this fuel savings relative to the investment required, a comparison of the program funding with that planned by other Federal agencies for energy conservation, an examination of the private industry aeronautical research and technology financial posture for the period FY 76 - FY 85, and an assessment of the potential impacts on air and noise pollution. To aid in this analysis, a computerized fleet mix forecasting model was developed. This model enables the estimation of fuel consumption and present worth of fuel expenditures for selected commerical aircraft fleet mix scenarios.

RAILWAY

REFER ALSO TO CITATION(S) 8743

8690 **Gasturbine propulsions of the German Federal railway.** Feulner, A. *Motortech. Z.;* **36**: No. 6, 161-167(Jun 1975). (In German with English abstract).

An evaluation is made of th locomotives with gas turbine propulsion. Compared to diesel engines with equal weight of the power unit, the installed power obtained from gasturbines amounts to two or three times the power of a diesel propulsion. In comparison to diesel engines, disadvantages are the double price, higher maintenance cost and increased fuel consumption. Experimental service results describe the difficulties of adapting an improved flight engine with regard to the given requirements when using it as a main drive in a railcar.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 8610, 8711, 8722

8691 (DOT-TST—77-29) **Mass transit development for small urban areas; a case study: Tompkins County, N.Y. Second-year final report.** Meyburg, A.H. (Cornell Univ., Ithaca, N.Y. (USA). Coll. of Engineering). Nov 1976. 342p. NTIS.

This report presents the results of the second-year effort within a three-year research project to develop a transportation planning methodology for small urban areas concerned with the provision of public transportation service. This phase of the research concentrates on problems of access to health services, transportation service for the disadvantaged, potential coordination and integration of existing transportation systems, alternative systems designs and their evaluation, and suitable marketing and monitoring programs for public transportation service in small urban areas. This effort, together with elements of the first-year research will culminate in the preparation of a transit planning manual suitable for use by the transportation planner in small to medium-size urban areas.

INDUSTRY AND AGRICULTURE

8692 **Voluntary industrial energy conservation.** Washington, DC; Department of Commerce (1977). 138p. (NP—22454).

This publication is the fifth in a series of reports showing progress in energy conservation made by industry. The report contains information on industry's achievements in conserving energy and provides new data on energy use and savings for the full year 1976. Also listed are those industries which are developing industrial energy efficiency reporting systems, and the industries which have been contacted by the Department of Commerce regarding participation in the Voluntary Industrial Energy Conservation Program. The principal information presented in each industry report are: progress towards industrial energy efficiency targets, recent energy trends, and brief background information. Also, most reports show percentage breakout and description of energy use. Included for the first time are bar graphs showing basic energy use patterns for 1976 compared to the base year when such information is included in the industry group's report. Fifty industry groups provided data for this report.

MATERIALS

8693 (PB—267568) **Impacts of material substitution in automobile manufacture on resource recovery. Volume II. Appendices A-E. Final report.** Renner, R.; Roig, R.W.; Jones, T.; Weaver, C. (IR and T, Arlington, Va. (USA)). Jul 1976. Contract EPA-68-01-3142. 168p. (IRT—403-R-Vol-2). NTIS PC A08/MF A01.

Probable changes in the mix of materials used to manufacture automobiles were examined to determine if economic or technical problems in recycling could arise such that the 'abandoned automobile problem' would be resurrected. Future trends in materials composition of the automobile were quantified, and possible constraints related to material characteristics, availability, and price were examined. The automobile resource recovery industry was studied in terms of economic incentives for recycling and technical obstacles to recycling of deregistered automobiles. A macro-model of the economy, the EPA sponsored SEAS model, was used to study overall economic and environmental effects and to bring to light any secondary effects that might be important. Appendices covering the following are presented subjects: (1) future material composition in automobiles; (2) projections of automobile sales by weight class; (3) automotive use of plastics and recycling possibilities; (4) safety aspects of materials substitution; and (5) energy consequences.

8694 (PB—267569) **Impacts of material substitution in automobile manufacture on resource recovery. Volume III. Appendices F-G. Final report.** Henn, W.L.; Watson, A.L. (IR and T, Arlington, Va. (USA)). Jul 1976. Contract EPA-68-01-3142. 115p. (IRT—403-R-Vol-3). NTIS PC A06/MF A01.

This volume contains appendices covering the following subjects: (1) Future Scrap Requirements and Prospects for Automotive

Recycling; (2) Demand, Availability, and Price of Steel and Substitute Materials for Automobile Manufacture.

8695 (PB—267570) **Impacts of material substitution in automobile manufacture on resource recovery. Volume IV. Appendices H-J. Final report.** Henn, W.L.; Roig, R.W.; Watson, A.L. (IR and T, Arlington, Va. (USA)). Jul 1976. Contract EPA-68-01-3142. 90p. (IRT—403-R-Vol-4). NTIS PC A05/MF A01.

This volume contains appendices covering the following subjects: (1) shedder industry survey; (2) material substitution and automobile performance; (3) integrated analysis of the impact of automobile composition changes using the strategic environmental assessment system.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 7980, 8577, 8638, 8656, 8687, 8704, 8731

8696 (N—77-24082) **An avionics sensitivity study. Volume 1: operational considerations. Final report, Aug. 1975 - Sep. 1976.** Scott, R.W.; Mcconkey, E.D. (Champlain Technology, Inc., West Palm Beach, Fla. (USA)). Sep 1976. Contract NAS1-14144. 230p. (NASA-CR—145107). NTIS PC A11/MF A01.

Equipment and operational concepts affecting aircraft in the terminal area are reported. Curved approach applications and modified climb and descent procedures for minimum fuel consumption are considered. The curved approach study involves the application of MLS guidance to enable execution of the current visual approach to Washington National Airport under instrument flight conditions. The operational significance and the flight path control requirements involved in the application of curved approach paths to this situation are considered. Alternative flight path control regimes are considered to achieve minimum fuel consumption subject to constraints related to air traffic control requirements, flight crew and passenger reactions, and airframe and powerplant limitations.

8697 (PB—268650) **Control characteristics of carbon beds for gasoline vapor emissions. Final report, Jan 1976—Jan 1977.** Manos, M.J.; Kelly, W.C. (Scott Environmental Technology, Inc., San Bernardino, Calif. (USA)). Feb 1977. Contract EPA-68-02-2140. 114p. NTIS PC A06/MF A01.

The report gives results of a study of the practical working capacity of activated carbon to cyclically adsorb gasoline vapor which would otherwise be lost to the atmosphere; e.g., during gasoline transfer operations at a service station. Quantitative measurements, made in the laboratory, were extrapolated to represent typical operation of a carbon control system at a service station pumping 50,000 gallons of gasoline per month. Eight types of activated carbon from four manufacturers were evaluated to determine working capacity, basically defined as the amount of gasoline vapor which could be cyclically adsorbed per 100 grams of virgin activated carbon. Tests were conducted at various levels of fuel volatility, lead content, carbon bed shape, ambient temperature and humidity, purge air flow rate and temperature, and vacuum-stripping pressure and temperature.

8698 **Some results of the investigation of power and technological schemes with screw-type expansion machines.** Zarnitskii, G.E.; Repin, L.A.; Chernin, R.A. (Krasnodarsk Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 5, 76-80(May 1977). (In Russian).

Results of an experimental investigation of a screw-type expander on a setup designed by Krasnodar Polytechnical Institute are presented. The results of tests of a number of screw-type expanders based on serially produced screw-type compensators are analyzed. For two technological schemes of work, graphs of variation of the productivity, adiabatic efficiency, and temperature drop depending on the number of revolutions of the machine are presented. Application of this machine to remove gasoline from casing-head gas is described.

8699 **Opportunities for saving energy by installing automatic defrosting controls in industrial cooling plants with air recirculation.** Mueller, E.D. (Hause Honeywell, Offenbach, Ger). *Klima Kaelte Ing.;* **5**: No. 4, 131-134(Apr 1977). (In German).

The present conventional methods for starting defrosting processes and their control characteristics are described, but also the engineering problems with automatic defrosting controls up to now applied. The gaging of the temperature gradient for starting defrosting offers economical and other advantages to the operator of installations owing to the application of automatic defrosting control.

8700 **Mechanical system instrumentation: a must for TAB and energy conservation.** Mannion, G.F. (Mannion Mechanical Services, Inc., Naperville, IL). pp 22-26 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

An overall view is necessary for the instrumentation of mechanical systems. There are two general categories of instrumentation. The systems of general interest that require instrumentation fall into the following categories: water flow, air flow, electrical, combustion, and steam systems. Instrumentation needed for these systems is considered. (MCW)

8701 **Dynamic efficiency of a gas-fired boiler.** Garbern, D.; Kelly, G.E. (National Bureau of Standards, Washington, DC). pp 330-335 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

The effect of cycling rate and part-load operation on the efficiency of a gas-fired, cast iron, hydronic boiler was examined in the laboratory. The boiler studied has an input rating of 300,000 Btu/h (316,500 kJ/h). Experimental curves are presented which show how the measured efficiency varied with the rate of cycling at several different heating loads. It was found that the cycling rate had only a slight effect on the part-load efficiency of the gas-fired boiler.

8702 **Computer simulation of fossil-fuel-fired boilers.** Chi, J. (National Bureau of Standards, Washington, DC). pp 336-346 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume II. Newman, P. (ed.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P2.

After an analytical boiler model is established, which is both an adquate representation of the physical system and capable of reasonably simple mathematical description, governing equations based upon this model are derived. A computer program DEPAB (Design and Performance Analysis of Boilers) is then developed to simulate boiler operations. DEPAB is designed to predict the performance of both the gas-fired and oil-fired hydronic boilers. Accuracy of results from computer simulation has been verified by the experimental data on a gas-fired boiler. Verification for the oil-fired boiler will be made in the future, when experimental data become available to the author. Examples are given to illustrate applications of the program to examine quantitatively the effects of design and operating variables on performance and seasonal fuel economy of heating boilers for buildings. It was found that considerable seasonal savings in fuel can often be achieved by performing certain modifications to the existing boilers.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 8578, 8707

8703 (PB—266961) **Development and testing of a wastewater recycler and heater. Final report.** Guarino, V.J.; Bambenek, R.A. (Chemtric, Inc., Rosemont, Ill. (USA)). Dec 1976. Contract EPA-68-03-0436. 106p. NTIS PC A06/MF A01.

The results of this program have demonstrated the feasibility of an automatic and self-contained appliance that can recover and store usable hot water from waste laundry water, using essentially the same amount of energy as an equivalent-capacity water heater. It has been shown by extended evaluation tests with a waste stream of real laundry water that this unit is capable of recovering sterile hot water at a steady state rate of 22.7 liters/hour (6 gph) with a specific energy draw of 79 watt-hours/liter (299 watt-hours/gal), without the use of any expendable chemicals. It has also been shown by extended evaluation tests with a feed that simulates hospital wastewater preconcentrated by ultrafiltration and reverse osmosis that this unit can increase the solids concentration of a waste water from less than 2% to at least 29.3%. The results of a manufacturing cost analysis have shown that a conservative annual cost (that is, a maximum annual cost) of this appliance is $717 per year. Economic feasibility therefore is not demonstrable at present on a large scale. However, should water cost increase or the cost of the appliance decrease, a viable demand for household water recovery with the appliance would be possible.

8704 (PB—268454) **Energy utilization analysis, Chestertown poultry plant, Campbell Soup Company.** Zwillenberg, M.; Nwude, J.; Narayanan, R.; Hamel, B.; Brown, H. (Drexel Univ., Philadelphia, Pa. (USA)). Apr 1976. 139p. NTIS PC A07/MF A01.

The purpose of the study is to develop the data base for the formulation, analysis, and design of potential energy conservation systems applicable to the Chestertown facility, with possible transferability to other parts of the food-processing industry, and other industries characterized by similar energy use patterns. This report details the energy flows to, from, and within the plant, and suggests a number of methods of recovering and conserving energy and reducing energy costs. These methods include waste heat recovery using heat exchangers and heat pumps, on-site electric power generation producing by-product process steam or hot water, and the replacement of high temperature steam by lower temperature hot water for many process and heating applications.

8705 **Recovery of heat from light alloy melting furnaces at Cegedur Pechiney.** Lailler, P. *Rev. Alum.;* No. 461, 197-203(Apr 1977). (In French).

At the present state of realization of planned fuel economy measures seven light alloy melting furnaces have been equipped with heat recuperators which make it possible, by preheating combustion air, to save 30 million therms per year, or about 14% of the fuel consumed by these furnaces.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 7995

8706 (BM-IC—8750) **Bureau of Mines research and resource recovery: reclamation, utilization, disposal, and stabilization.** Spendlove, M.J. (Bureau of Mines, College Park, Md. (USA). College Park Metallurgy Research Center). 1977. 109p. of Mines, Washington, DC.

The Federal Bureau of Mines has been a leader in resource recovery research since it was founded in 1910. Until the early 1960's, most of the projects were concerned primarily with the task of extending and improving conventional technology oriented to secondary metals and minerals upgrading and processing for marketable products of highest value. By the mid-1960's with the passage of the Solid Waste Disposal Act of 1965, all resource recovery research programs were increased in scope and intensity as an effort to solve the growing number of environmental problems and the rapid depletion of domestic energy and mineral resources. Many new materials were investigated including urban refuse, manufacturing, industrial wastes, and stockyard wastes. The objective was to promote maximum recycling as the most practical answer to problems of waste disposal, pollution control, and the short supply of minerals and energy. The new research projects ranged from the conversion of animal manure and other organics to oil, to the recovery of precious and common metals from demolished aircraft and electronic scrap. This profile includes brief descriptions of many selected research projects that typify the total spectrum of Bureau of Mines research in the important field of resource recovery.

8707 (PB—267324) **Disposal of feedlot wastes using a two-stage oxidation process with net energy production. Project completion report, 1 Jul 74-Jun 76.** Bishop, K.A.; Rosson, H.F. (Kansas Water Resources Research Inst., Manhattan (USA)). Jan 1977. Contract DI-14-31-0001-5016. 73p. (CONTRIB—186). NTIS PC A04/MF A01.

Control of water pollution from feedlot operations continues to be a major problem. In certain cases, the choice of a disposal process which will result in a saleable by-product could partially or completely defray the expense of manure disposal. A process in which energy is the by-product is thermodynamically feasible; about half of the heating value of the manure can be recovered as useful thermal energy. A process was envisioned in which wet undried feedlot manure would undergo a wet oxidation reaction followed by a second incineration step to complete the oxidation, with requisite heat exchange to recover thermal energy. In support of the wet oxidation step, experimental data on heating value, equilibrium oxidation, and kinetic rate were obtained. Because small particle size tends to favor rapid kinetics, control thereof should lead to lower pressure operation in smaller equipment, resulting in capital and operational economies.

8708 (PB—268308) **Alternatives to Type II cement. Part I. Preliminary laboratory studies. Interim report.** Ozyildirim, H.C. (Virginia Highway and Transportation Research Council, Charlottesville (USA)). Feb 1977. 37p. (VHTRC—77-R38). NTIS PC A03/MF A01.

In this study, concrete mixtures incorporating fly ash are being investigated as possible alternatives to mixtures using Type II cements. The mixture characteristics being considered are strength, resistance to freezing and thawing and sulfates, heat of hydration, and volume stability. Control mixtures are made of Type I, II, and III cements. In the experimental mixtures, Type IP cement - a blend of ordinary cement and fly ash- and Type I cement with fly ash as an admixture are being used. This report gives the results of initial tests for compressive and flexural strengths, resistance to rapid freezing and thawing, early volume change, time of set, and heat of hydration.

8709 **Reverse osmosis to achieve water control and recycle.** Heizer, R.T.; Plock, C.E. *Desalination;* **20**: No. 1/2/3, 61-69(Mar 1977).

A 648,000 GPD reverse osmosis (RO) facility at ERDA's Rocky Flats Plant near Golden, Colorado will convert tertiary sewage plant effluent for recycle as cooling tower makeup to reduce external water demand and achieve "zero discharge" off-site of tertiary sewage effluent. Design parameters for the facility, determined by three years of pilot plant testing, include 98% feedwater recovery, 100 ppM T.D.S. product water, and minimum brine production for evaporation to dryness. Pretreatment consists of RO feed attenuation in a large pond, chlorination, sand filtration, softening, diatomaceous earth filtration, feedwater heating and pH adjustment. The RO plant will have three 150 GPM trains, each with a combination of HFF modules producing about 90% of the permeate, followed by SW modules producing the final 10%. Permeate from the SW modules can be combined with permeate from the HFF modules or returned to the RO feed stream. Unique design considerations include heating the 40 to 70°F fee to 77°F by means of heat recovery from the permeate and supplemental steam heating, recycling of pretreatment backwash streams wherever possible to reduce the volume of brine, and precautions to avoid silica scaling of the modules.

MUNICIPALITIES AND COMMUNITY SYSTEMS

CONSERVATION SERVICES

8710 (PB—267546) **Increased transportation efficiency through ridesharing: the brokerage approach. Volume I. Final report.** Davis, F.W. Jr; Barnaby, D.J.; Bell, T.L.; Hood, T.C.; Wegmann, F.J. (Tennessee Univ., Knoxville (USA). Transportation Center). Nov 1976. Contract DOT-OS-40096. 223p. (TC—76-018). NTIS PC A10/MF A01.

Ridesharing is the process of improving transportation efficiency by increasing vehicle occupancy. Brokerage is the process by which ridesharing is promoted, coordinated and implemented. Brokerage is built on the concept of matching specific individual needs with a broad array of transportation services. The report defines the brokerage concept, describes benefits, assesses market potential, describes mechanisms for determining needs, outlines methodology for comparing costs of alternative types of service, identifies institutional barriers to program implementation and develops strategies for increasing ridesharing.

PUBLIC SERVICES

8711 (DOT-TST—77-69) **Low-cost bicycle path pavements. Final report, September 1, 1975—November 30, 1976.** Lai, J.S. (Georgia Inst. of Tech., Atlanta (USA). School of Civil Engineering). Dec 1976. vp. NTIS.

The proposed research involves an analytic and experimental investigation to develop realistic design criteria for bicycle path pavements. The research also included evaluation of specific designs and innovative low-cost material systems for use in bicycle path pavements. An extensive literature review of currently existing and experimental bikepath pavement was also included. Results from this report indicate that the strength and durability of Class I bikepath pavements can be improved and the construction cost can be reduced through better design and construction practices and use of low-cost material systems.

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 8576

8712 (N—77-22005) **Design techniques for modular integrated utility systems.** Wolfer, B.M. (National Aeronautics and Space Administration, Houston, Tex. (USA). Lyndon B. Johnson Space Center). Feb 1977. 78p. (NASA-TM-X—58189; JSC—10747). NTIS PC A05/MF A01.

Features basic to the integrated utility system, such as solid waste incineration, heat recovery and usage, and water recycling/treatment, are compared in terms of cost, fuel conservation, and efficiency to conventional utility systems in the same mean-climatic area of Washington, D. C. The larger of the two apartment complexes selected for the test showed the more favorable results in the three areas of comparison. Restrictions concerning the sole use of currently available technology are hypothetically removed to consider the

introduction and possible advantages of certain advanced techniques in an integrated utility system; recommendations are made and costs are estimated for each type of system.

8713 Heat recovery from wastewaters for household space heating. Pemberton, E.V. (Univ. of Waterloo, Ont.). *J. Environ. Sci. Health, Part A;* **12**: No. 8, 389-392(1977).

The potential for using heat recovered from household wastewater for space heating is explored. A breakdown of the average household's daily production of 240 gallons of wastewater is analyzed to determine a recoverable heat potential of 50,000 Btu per day. Two types of dwelling, well-insulated single family and multi-family, are estimated to have a potential of 30 percent and 80 percent, respectively, of their space heating requirements available with a heat pump recovery system. Research would be needed to solve the problems of congealed soap and fatty materials in the equipment. Legislation would also be needed to change public health requirements in many areas. Cost estimates indicate that this type of system is only economically feasible for the multi-family residence. (DCK)

8714 Storage system selection techniques for optimizing energy conservation in utility services. Rippey, J.O. (National Aeronautics and Space Administration, Houston, TX). pp 119-125 of In Proceedings of the conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings. Volume I. Goldschmidt, V.W.; Didion, D.; Newton, A.B. (eds.). West Lafayette, IN; Purdue Research Foundation (1976).

From Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings; Lafayette, Indiana, United States of America (USA) (12 Apr 1976).

See CONF-760488—P1.

The results of an investigation into the potential benefits from a variety of energy storage systems as they are incorporated into math models of integrated utility systems that serve a 1000-unit apartment complex and a village complex are presented. Representative daily load profiles on a seasonal basis for the utility services were approximated for median United States weather characteristics to produce possible energy storage potentials and annual summations. Existing, developing, and conceptual energy storage systems that could reasonably be incorporated into the integrated utility system concept were analyzed. The methodology in determining the most advantageous energy system for the complexes modeled is summarized in this study as a demonstration for possible application to other utility systems. The results of this study indicate that although significant advancements have been made in potential storage materials and associated storage techniques, the simplicity and relatively low cost in energy storage with sensible heat of water continues to be the best system available for the majority of applications.

MUNICIPAL WASTE MANAGEMENT

8715 (PB—267373) Recovery of landfill gas at Mountain View. Engineering site study. Final report. Carlson, J.A. (City of Mountain View, Calif. (USA)). 1977. 71p. NTIS PC A04/MF A01.

The objective of the project was to determine how much methane gas can be withdrawn from a shallow sanitary landfill at a suitable quality and quantity to make it economically feasible for commercial use. The site of the sanitary landfill is Shoreline Regional Park in the City of Mountain View, California. The typical depth of the landfill is 40 feet. This report investigates the viability of producing methane gas from a shallow sanitary landfill. By measuring the landfill gas composition, gas withdrawal rates, decomposition temperature, pH, and the pressures within the refuse, this project attempted to provide the composition and quality of the landfill gas, optimum gas withdrawal, well spacing and gas withdrawal rates, potential gas production rate, and the affect of varying the water moisture content of the refuse on the gas production.

8716 (PB—267629) An economic evaluation of a process to separate raw urban refuse into its metal, mineral, and energy components. Information circular. Phillips, T.A. (Bureau of Mines, College Park, Md. (USA). College Park Metallurgy Research Center). 1977. 32p. NTIS PC A03/MF A01.

An economic evaluation of the Bureau of Mines process for the separation of raw urban refuse into its metal, mineral, and energy components is presented. The process recovers ferrous metal, mixed nonferrous metals, aluminum, mixed-color glass cullet, and refuse derived fuel products from raw refuse. Data for this evaluation were obtained from selected runs at the Bureau's pilot plant in Edmonston, Maryland. A cost estimate was prepared for a plant capable of processing 1,000 tons per day of raw urban refuse operating 2 shifts, 6 days per week. The fixed capital cost, based on second quarter 1976 equipment costs is $14,529,600 excluding land and shipping facilities. The estimated operating cost is $7.96 per ton of refuse processed. This does not include credit for the products, transportation of the products, a tipping fee, or a dumping fee for wastes produced. No finance charges or taxes are included in the operating costs.

8717 (PB—268327) Abandoned automobile removal. Final report. (Kentucky Dept. for Natural Resources and Environmental Protection, Frankfort (USA)). 1977. 32p. NTIS PC A03/MF A01.

This report gives a detailed study of two pilot projects, which helped to improve the market for abandoned vehicles, plus a full-scale demonstration project, which was to improve overall solid waste management by recovering, for recycling, as many junked and abandoned vehicles as possible in 15 selected counties. The benefits of the program were many. During the project year, over 5,000 abandoned vehicles were collected and recycled. Each car was converted into approximately one ton of steel. Local sponsors received about $100,000 from the sale of the junked cars to recycling firms. Therefore, aesthetic, environmental, and monetary goals were all met. Discussion of future program needs and legislative recommendations were also included in this report.

8718 (PB—268708) Sanitary landfill operator's manual. (Iowa Dept. of Environmental Quality, Des Moines (USA). Land Quality Management Div.). May 1977. 146p. NTIS PC A07/MF A01.

This manual gives specific requirements and suggested procedures for operating a sanitary landfill. Some of the problems which could develop at a sanitary landfill, and how to avoid them, are discussed. Solid waste rules from the Code of Iowa and from the Iowa Department of Environmental Quality are included, as well as surveying techniques. The following topics are discussed: sanitary landfill operation; cell construction; roads and traffic control; inclement weather operations; vector and litter control; monitoring for leachate; hazardous waste disposal procedure; sewage sludge disposal in a sanitary landfill; sanitary landfill equipment; map reading; OSHA and safety; records; inspections; sources of assistance.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 8657

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 8696

8719 Calculation of steady flow of a fuel-and-air mixture. Ibragimov, V.I.; Kiselev, B.A. (Sci Res Inst of Automob and Automob Engines, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 92-97(1977). (In Russian).

Formulation of a steady-state flow problem of a fuel-and-air mixture in a straight pipe is considered, taking into account the mechanical, thermal and mass exchange interaction between droplets of fuel and the steam-and-air carrier flow. A method to solve the problem and some results are also presented.

8720 Determination of the moment of rotational momentum of a fresh charge in cylinders of internal combustion engines. Ivanov, M.Yu.; Kiselev, B.A. (Sci Res Inst of Automob and Automob Engines, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 107-114(1977). (In Russian).

A method of computational determination of the moment of rotational momentum of a fresh charge, taking into account the eccentric position of the valve, the real velocity diagram, structure, and interaction between the stream emerging from the valve slot and the cylinder walls, is considered.

8721 Model of flow for through parts of internal combustion engines. Kamkin, S.V. (Leningrad Higher Eng Naut Sch, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 114-119(1977). (In Russian).

Unsteady flows in through parts of internal combustion engines are represented by a hydraulic model of step-by-step instantaneous mixing in finite volumes. This model reflects discontinuous and continuous flows of gas and permits determination of hydrodynamic parameters vitally important for the evaluation of gas exchange quality indices and energy characteristics of supercharging systems.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 8761

8722 (PB—268582) **Evaluation of automotive fuel flowmeters.** Robertson, B.; Baumgarten, G.P. (National Bureau of Standards, Washington, D.C. (USA). Inst. for Basic Standards). Jun 1977. 99p. (NBS-TN—943). NTIS PC A05/MF A01.

Fuel economy measurement procedures being developed by the Transportation Systems Center of the Department of Transportation require flowmeters to measure the gasoline consumed by the engine of an automobile either on the road or on a dynamometer. The contribution of the National Bureau of Standards to this work was to ascertain the environment in which the flowmeters will probably be used, to develop procedures for measuring their performance in a laboratory simulation of that environment, and to carry out illustrative measurements on a number of flowmeters. This report discusses: (1) the environment of the flowmeter in an automobile, i.e., flowmeter temperature; fuel temperature, pressure, density, viscosity, color, opacity, flow pulsations, back flow, and swirl due to elbows; line voltage fluctuations; electromagnetic radiation from ignition; vehicle attitude with respect to the vertical; and vibration, (2) the test set-up and procedure used for evaluating and calibrating these meters in the laboratory under conditions simulating the automotive environment, (3) a discussion of possible sources and magnitudes of errors in the calibration, and (4) results of illustrative tests on seven flowmeters.

8723 **Computer simulation of gas dynamic processes of a two-stroke engine.** Ferrari, G. (Politec di Milano, Italy). *Termotecnica (Milan);* **31**: No. 4, 196-203(Apr 1977). (In Italian).

A computer model is developed which makes use of the method of characteristics to solve general equations of one-dimensional, unsteady, non adiabatic and viscous flow during the scavenging and intake process of a two-stroke engine. It allows gasdynamic testing of the performance of intake and exhaust systems of a loop-scavenged engine for a motorcycle, and all dynamic and thermodynamic quantities in the manifold can be computed during the cycle. Experimental results are given which indicate a fair agreement between experiments and theoretical calculations.

8724 **Two-stage combustion of a stratified mixture.** Sobolev, L.M. (Kostroma Agric Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 2, 70-72(1977). (In Russian).

Results of comparative tests of an identical motor with four different working processes are presented. The efficiency of two-stage combustion of stratified mixtures is demonstrated. The tests show that the method of fuel spray afterburning of nonuniformly distributed working mixture in the combustion chamber, periodically separated into two cavities, solves the problem of sharp reduction of the toxicity of exhaust gases and increases the efficiency of the light fuel-burning engine.

DIESEL

REFER ALSO TO CITATION(S) 8761

8725 **Working process in a diesel engine with stratified mixture formation and premix chamber-flame ignition.** Mekhtiev, R.I. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 97-102(1977). (In Russian).

Specific features of the working process of an engine with an ejection system of fuel injection into the cylinder and flame ignition are elucidated. Theoretical aspects of the process of mixture formation in the premix chamber are considered. They permit establishment of the regularities of variations of the composition of the igniting and cylinder charges under different speed and loading conditions of engine operation.

8726 **M.a.n. m-combustion system in the passenger car diesel engine.** Neitz, A. (Maschinenfabrik Augsburg-Nuernberg, Ger). *SAE Prepr.;* No. 770434, 1-13(1977).

This paper discusses the use of the direct-injection "M" combustion system in a small high-speed Diesel engine. Experimental and test results are given for a passenger car whose 60-HP (DIN) four-cylinder engine with 2.2 litres (134 in^3) displacement was converted for the "M" system. The combustion system, which is being widely used in commercial vehicle engines, possesses advantageous features which make it attractive for use in passenger cars on account of its inherently low fuel consumption and noise level. The author describes modifications of the combustion process which enable substantial improvements to be achieved in exhaust gas quality.

8727 **Regenerative engine-test brakes cut costs and increase efficiency.** *Automot. Eng. (London);* 2: No. 3, 19, 45(1977).

A program to test dc regenerative electrical brakes for automotive diesel engines is described. A discussion is given of the test facilities to be used and the economics and operational advantages of the system. (PMA)

8728 **Power units for the future: gasoline or diesel.** Garrett, K. *Automot. Eng. (London);* 2: No. 3, 58-59(1977).

A brief report is given of a recent conference where some widely varied views were expressed on the diesel engine and its performance in private cars. Topics discussed include engine cost, exhaust gases, noise, driveability, and fuel consumption. Research programs at Peugeot, Alfa Romeo, and Shell International are described. (PMA)

8729 **Fouling of piston group in engines.** Grigor'ev, M.A.; Efremov, V.N.; Artem'ev, V.A. (Yaroslavl' Eng-Build Plant, USSR). *Chem. Technol. Fuels Oils (USSR) (Engl. Transl.);* **12**: No. 9-10, 719-722(Sep-Oct 1976).

Results are presented from a study of the dynamics of piston-group fouling in carburetor and diesel engines. It has been established that, in the process of engine operation, the quantity and degree of piston-group fouling will increase sharply in the initial period; then the fouling rate falls off, and, after a certain time of operation, the amount of fouling stabilizes at some specific level. The higher the quality of the oil and the better the detergent and dispersant properties of the oil, the longer will the engine operate before stabilization of the level of piston-group fouling. Data are presented on piston fouling and on fouling of individual sections of piston as functions of operating time for a YaMZ-238N diesel with turbosupercharger. The tests were performed in a test stand under high-temperature, high-load severe conditions in accordance with GOST 14846-69 (maximum-power regime). It is demonstrated that, when either the Group G or Series 3 oil is used, the fouling of the piston and of its individual sections increases sharply during the initial period, then gradually stabilizes at a certain level that depends on the quality of the oil used.

TURBINE

8730 (CONS/1011—18) **Experimental evaluation of premixing: prevaporizing fuel injection concepts for a gas turbine catalytic combustor.** Tacina, R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. Contract EX-76-A-31-1011. 19p. (NASA-TM—73755; CONF-771120—1). Dep. NTIS, PC A02/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, Georgia, USA (27 Nov 1977).

Experiments were performed to evolve and evaluate a premixing-prevaporizing fuel system to be used with a catalytic combustor for possible application in an automotive gas turbine. Spatial fuel distribution and degree of vaporization were measured using Jet A fuel. Three types of air-blast injectors, an air-assist nozzle and a simplex pressure atomizer were tested. Air swirlers with vane angles up to 30° were used to improve the spatial fuel distribution. The work was done in a 12-cm (4.75-in.) diameter tubular rig. Test conditions were: a pressure of 0.3 and 0.5 MPa (3 and 5 atm), inlet air temperatures up to 800°K (980°F), velocity of 20 m/sec (66 ft/sec) and fuel-air ratios of 0.01 and 0.025. Uniform spatial fuel distributions that were within +-10% of the mean were obtained. Complete vaporization of the fuel was achieved with airblast configurations at inlet air temperatures of 550°K (530°F) and higher. The total pressure loss was less than 0.5% for configurations without air swirlers and less than 1% for configurations with a 30° vane angle air swirler.

8731 **Characteristics of turbine with controlled nozzle rings.** Barskii, I.A. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 1, 91-94(1977). (In Russian).

An experimental investigation shows that, with a decrease in the angle α_1, the efficiency of the turbine with cylindrical blades changes less than that of the turbine with twisted blades, the absolute efficiency of which is, however, higher by 1-2%.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 8745, 8748, 8749

8732 (EDP/C—01(77)) **Electric vehicle systems, FY 1978.** (Energy Research and Development Administration, Washington, D.C. (USA)). Aug 1977. 118p. Dep. NTIS, PC A06/MF A01.

An Environmental Development Plan (EDP) is described which identifies the environmental, ecological, social/economic, health, safety, and natural resource issues associated with the ERDA research, development, and demonstration (RD and D) of electric vehicles used for personal highway transportation and presents an "environmental" research and development strategy for resolving the issues. The following are considered: (1) incorporating environmental considerations into agency planning processes at the earliest stages; (2) resolving environmental issues concurrently with energy technology development; and (3) assuring that adverse environmental effects are mitigated through sound technological design and are at the same level of importance as technological, economic, and institutional issues in decisionmaking. Information contained in the

EDP constitutes an inventory of the status of environmental problems and a plan for resolving these problems. The electric vehicle provides an option to assist in decreasing petroleum dominance, especially in dense urban areas, as the energy source for the conventional automobile and light duty truck. It is also possible that substantial improvement in air quality may result in these areas if electric vehicles are deployed in large numbers and the emissions from central generating facilities are adequately controlled. ERDA plans call for electric vehicle systems development efforts leading to the demonstration of near-term technologies by 1980 and advanced technologies by 1985. The environmental issues addressed consider only the electric vehicle production, operation, and disposal subsystems and exclude issues associated with the production of electrical energy used to energize the electric vehicle batteries.

8733 (N—77-21549) **Results of baseline tests of the EVA metro sedan, citi-car, jet industries electra-van, CDA town car, and OTIS P-500 van.** Stenger, F.J.; Bozek, J.M.; Soltis, R.F. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Oct 1976. Contract E(49-28)-1011. 78p. (NASA-TM-X—73638; E—9140). NTIS PC A05/MF A01.

Five electric vehicles were tested at vehicle test tracks using the SAE. The tests provide range data at steady speeds and for several driving cycles. Most tests were conducted with lead-acid traction batteries. The Otis Van and the Copper Electric Town Car were also tested with lead-acid and nickel-zinc batteries. The tests showed a range increase of from 82 to 101 percent depending on vehicle, speed, and test cycle.

8734 (SAN/1295—1) **Near-term electric vehicle program: Phase I, final report.** (ASL Engineering, Inc., Goleta, Calif. (USA)). Aug 1977. Contract EY-76-C-03-1295. 205p. Dep. NTIS, PC A10/MF A01.

Phase I of the Electric Vehicle Design Program described was a preliminary design study for a four-passenger electric vehicle. Three major tasks were involved: a conceptual design/tradeoff study task in which design directions were established, a preliminary design task which developed the designs in more detail, and a development planning task which generated recommendations for a subsequent hardware development program. Each of these areas is discussed. The design and planning work was carried on under the guideline of using near-term technology and under the firm requirements to provide: (1) accommodations for four adults; (2) 55 mph cruising speed; (3) heater/defroster; (4) design life of 100,000 miles; and (5) completed test vehicle by June 1978. Design aspects discussed include propulsion system; batteries/charger, body/structure, chassis system, accessories, and weight.

8735 (TID—27715) **Task 4: development plan for electric-powered passenger vehicle program.** (AiResearch Mfg. Co., Torrance, Calif. (USA)). 3 Dec 1976. Contract EY-76-C-03-1213. 89p. Dep. NTIS, PC A05/MF A01.

The electric car must be a new design, specifically optimized for its intended use, and with an improved power system that will maximize the power and capacity available from an existing or near-term battery. In recognition of the above, the Energy Research and Development administration has sponsored the electric vehicle design program. The Phase I study of this program conducted by Garrett/AiResearch is essentially complete, and a number of important conclusions have been made. The three most important of these conclusions are: (1) the near-term goals of performance, range, and cost can be achieved by an advanced vehicle design; (2) a regenerative power system is required to meet the performance and range goals; and (3) an advanced frame and body design using lightweight materials is required to meet the performance and cost goals. This proposed development plan is submitted in compliance with the requirements of Task 4 of the Phase I study program. It describes a comprehensive, three-phase 54-month development program. This program has been carefully planned to develop the required technological improvements, integrate them into a safe and economical commuter car design, and to confirm, by test demonstrations, the validity of the design to achieve the intended goals. The program is planned in three phases; these phases are overlapped to allow completion of all objectives. All phases have been staggered to allow feedback of test results into the subsequent design tasks. The program is based heavily on the Phase I results, including the selected preliminary design. The design, the technical approach, and the development plan are summarized. The work that is to be done in each phase is described in detail. Each phase will have specific technical objectives and an updated economic analysis, including a cost, marketing, and manufacturing plan.

8736 (TID—27716) **Electric/hybrid vehicle development plan.** (ASL Engineering, Inc., Goleta, Calif. (USA)). [nd]. Contract EY-76-C-03-1295. 129p. Dep. NTIS, PC A07/MF A01.

The development plan given describes the approach which ASL/Engineering recommends for the design and development of advanced electric passenger vehicles as a logical continuation of the preliminary design effort performed in Phase I of the Electric Vehicle Design Program. This plan considered not just the problem of the design, fabrication, testing and delivery of "one-off" demonstration vehicles, which come as close as possible to meeting the ERDA vehicle design goals, but also the problem of phasing this development effort into the requirements of H.R. 8800, and, more generally, into limited commercial production. As a consequence, the plan includes discussions of such factors as FMVSS compliance testing, durability and reliability testing, tooling, and marketing. The approach recommended for future phases of ERDA's electric vehicle program involves the development of three basic design approaches for the propulsion system, any of which can be incorporated into the same basic vehicle design. The three propulsion system design approaches have been detailed in the Design Tradeoff Studies Report prepared under this contract; their basic characteristics are summarized, and the projected performance, operating range, and cost characteristics are given. Each of the approaches is currently at a different level of development. The motor is a design which has been built and tested by Prestolite, both on the dynamometer and in a vehicle. The controller is a commercially-available unit from Cableform, and the automatic transmission is a slightly modified production unit (VW Rabbit).

8737 **New transportation concept: a powered roadway.** *Battery Man;* **19**: No. 10, 2-3(Oct 1977).

The "Dual Mode Electric Transportation System" is described. This electric car system has a power source imbedded in the road, most practically in one lane of a freeway, in addition to a battery or flywheel. The source powers the vehicle while it is on the freeway and simultaneously recharges the battery in the vehicle for nonfreeway driving. Energy to run the vehicle is electromagnetically transferred from the strip to an energy pickup under the vehicle. A typical use scenario is given. Costs and pollution aspects of the system are discussed. (RWR)

8738 **Tropicana marks "the parting of the ways".** *Electr. Veh. Batteries;* **63**: No. 2, 8, 10(Jun 1977).

The Tropicana represents an unusual approach since it was basically created as an electric leisure vehicle but is likely to emerge as a fully fledged road vehicle. It is a stylish, open two/three seater with folded P.V.C. hood anf titted with a wide bench seat. Tropicana capable of traveling 50 to 60 miles between charges at speeds of up to 35 m.p.h. and able to climb 1 in 5 gradients. The strong tubular steel chassis is galvanised inside and out--a re-inforced plastic body completes the non-corrodable concept. An electric 7.5 h.p. motor is cradle mounted to the chassis, driving to an open propeller shaft. The controller is of the thyristor type with two contactors. The length overall is 128 in.; width overall 63 in.; wheelbase 74 in.; turning circle 25 ft.; height overall 54 in. Tropicana is manufactured in the United Kingdom by ElecTraction Ltd.

8739 **Do electric cars have a real chance in the future: conclusions from the electric vehicles symposium 1976 in duesseldorf, west germany.** Mutzner, J. (Tech Hochsch, Zurich, Switz). *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 3, 110-116(1977). (In German).

The symposium dealt with the status presently achieved with the development of electric vehicle systems and individual automobile components, such as batteries, drives, and control devices. Operational and economic aspects associated with electric traffic were also considered. The most important conclusions resulting from the symposium are discussed.

8740 **System analysis of electric traffic.** Mueller, H.G. (Ges fuer Elektr Strassenverkehr, Duesseldorf, Ger). *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 3, 116-122(1977). (In German).

The use of electricity as a secondary energy source instead of gasoline for automobiles is considered from the viewpoint of economy and energy. Special requirements associated with electric cars and their energy storage systems are discussed.

8741 **Present status of development of electric vehicles in the world.** Samuel, J.M.G. (Adv Vehicle Syst Ltd, Welwyn Carden City, Engl). *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 3, 122-129(1977). (In German).

Vehicles that are already in the production stage or will attain that stage shortly are described. Improvements in the development of storage batteries are discussed. RandD achievements in various countries are reported, particularly in the United States, Japan, Australia, Great Britain, France and Germany. Future aspects are considered.

8742 **Development of electric vehicles and their supply with energy in the countries of the European Common Market.** Gallot, J. (EdF, Paris, Fr). *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 3, 135-140(1977). (In French).

Problems associated with the development of electric automobiles are discussed. The expected potential in 1990 and the associated consumption of electricity under various assumptions are estimated. These estimates are made for France and the European Common Market.

8743 Development of superconducting magnets for magnetically suspended highspeed trains. Ogiwara, H.; Takano, N.; Okamoto, H.; Hayashi, K. (Tokyo Shibaura Electr Co, Kawasaki, Jpn). *Toshiba Rev., Int. Ed.;* No. 98, 7-11(Jul-Aug 1975).

Results of a three-year program to develop superconducting magnets for magnetically suspended high speed trains, are outlined.

8744 New design of the SCR type speed controller for the battery powered electric vehicles. Hwang, H.Y. *J. Korean Inst. Electron. Eng.;* **24**: No. 6, 85-91(1975). (In Korean).

A new design method for the SCR-chopper type speed controller for a battery-powered vehicle was developed. The conventional speed-controllers were either inductance- or contact-type using resistance. In the new method, a photocoupler was used in sensing the control currents and a noncontacting type photo-conductive device (CDS) was used in making acceleration. Experiments using these new devices showed encouraging results.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 8547, 8748, 8749

8745 (UCRL—79154) **Flywheel-battery hybrid power system: a concept to improve electric vehicle performance.** Davis, D.D.; Epps, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jan 1977. Contract W-7405-ENG-48. 42p. (CONF-770430—20). Dep. NTIS, PC A03/MF A01.

From 4. international symposium on automotive propulsion systems; Washington, District of Columbia, United States of America (USA) (17 Apr 1977).

A concept for powering the automobile was re-examined: a hybrid propulsion system design based upon demonstrated technology that could substantially improve performance, range, and consumer acceptability of a battery-powered electric vehicle. In the proposed power system, a high-energy composite flywheel is coupled to a simple, efficient, electro-mechanical transmission. Today's "state-of-the art" lead-acid as well as near-term and advanced battery types are examined as prime power sources. Interactive control of battery and/or flywheel drive power is provided by a versatile microprocessor-based power control unit. In the power system proposed, the flywheel augments the battery during periods of high power demand: starting, acceleration, and hill climbing. The battery supplies cruise-and-control power plus the energy required to replenish flywheel losses. With battery power demand stabilized at a low value, specific energy is maintained near maximum resulting in increased vehicle range. Vehicle kinetic energy is restored to the flywheel when traveling downhill or during any period of deceleration. The flywheel-battery hybrid is thus able to make efficient use of a regenerative braking system to recover energy. A one and a half times greater range, when compared to all-battery power, is predicted for the hybrid-powered vehicle when operated in a stop-and-go commuter environment. Acceleration rates approaching those of internal combustion powered vehicles are attainable with the hybrid power system.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 8547, 8745

VEHICLE DESIGN FACTORS

REFER ALSO TO CITATION(S) 8734, 8736, 8759

8746 (DOT-TST—77-48) **Contact stresses for closely conforming bodies: application to cylinders and spheres. Final report.** Woodward, W.; Paul, B. (Pennsylvania Univ., Philadelphia (USA). Dept. of Mechanical Engineering and Applied Mechanics). Dec 1976. 278p. NTIS.

Since worn wheels and rails contact conformally, the existing contact stress theories for nonconformal contact are not adequate. A general numerical method of solution for three dimensional frictionless, conformal, elastic contact problems is presented. The method is used to analyze the conformal contact of a sphere indenting a spherical seat and a cylinder indenting a cylindrical seat. The results of the sphere-spherical seat problem compared well with experimental data. Results of the cylinder-cylindrical seat problem were in close agreement to a known analytic solution of this problem. For both analyses, results compared favorably with Hertzian theory for problems with small contact regions. A method is given for defining the boundaries of the large contact regions, and for solving the associated governing singular integral equation of the first kind. A general iterative procedure is developed which converges to the true three dimensional contact region. In addition the solution to a non-Hertzian contact problem with a multiply connected contact region is solved; namely, the case of two spheres in contact where one of them has a surface defect or pit.

BODY AND CHASSIS

8747 Rational dynamic loads analysis for air cushion vehicles in random seaway or terrain. Bartholomew, R.J. (Aerojet-General Corp., Tacoma, WA). *J. Hydronaut.;* **9**: No. 3, 90-98(Jul 1975).

From AIAA/SNAME advanced marine vehicles conference; San Diego, CA, USA (25 Feb 1974).

A probabilistic approach is suggested as a rational method of assessing dynamic loads prevailing on an air cushion vehicle operating in a random seaway or terrain. The hull load distributions, expressed in terms of shear force, bending moment, and torsion moment, are based on a criterion of selecting an acceptable frequency of occurrence of loading determined from the mission requirements of the vehicle. The method also includes a rational approach to the problem of combining static loads with stationary random dynamic loads (seaway or terrain) and nonstationary dynamic loads (wave slamming, terrain impact).

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 8726, 8727

8748 (UCRL—52306/1) **Determination of the effectiveness and feasibility of regenerative braking systems on electric and other automobiles. Volume I. Summary. Final report.** Davis, D.D.; Renner, R.A.; Younger, F.C.; Epps, R.C.; Lerner, S.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Sep 1977. Contract W-7405-ENG-48. 77p. Dep. NTIS, PC A05/MF A01.

A report is given of a study conducted by Lawrence Livermore Laboratory in which a determination of the effectiveness and feasibility of regenerative braking systems on electric and other automobiles was made. Regenerative braking concepts applicable to autos utilizing electric, hybrid, or heat engine power systems were evaluated to determine performance improvement, energy savings, and cost effectiveness. Two major conclusions were reached pertaining to privately owned autos driven 16,100 km/yr in an urban environment: (1) regenerative braking is cost effective and is recommended for use on electric and hybrid-powered automobiles, and (2) the addition of a regenerative braking system to the standard heat-engine-powered auto was not found to be cost effective. However, the regenerative system can be cost effective for heat engine powered commercial vehicles such as taxis, city buses, or delivery vans that see high annual usage under stop-and-go conditions.

8749 (UCRL—52306/2) **Determination of the effectiveness and feasibility of regenerative braking systems on electric and other automobiles. Volume II. Design study and analysis. Final report.** Davis, D.D.; Renner, R.A.; Younger, F.C.; Epps, R.C.; Lerner, S.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Sep 1977. Contract W-7405-ENG-48. 289p. Dep. NTIS, PC A13/MF A01.

The second of two volumes is presented which document an investigation of regenerative braking systems. This volume presents the details of the analysis performed plus appendices in which study team members and organizations contacted are listed and supporting data are compiled. Volume 1 is entitled, "Determination of the Effectiveness and Feasibility of Regenerative Braking Systems on Electric and Other Automobiles—Summary."

8750 Acquisition and computer calculation at the test centre for propulsion systems. Mirailles, B. (Cent d'Essais de Propul, Fr). *Rev. Gen. Electr.;* **86**: No. 4, 320-322(Apr 1977). (In French).

In order to carry out the aircraft engine tests, which are its main activity, the Test Centre for Propulsion Systems in Saclay was equipped in 1967 with a very centralised automated measuring system controlled by an industrial computer in charge, in addition, of carrying out thermodynamic calculations either in "real time" or in "dead time". The increasing requirements of the Test Division and the aging of the "first generation" equipment, have led the Data Processing Service to design and select a new solution. The selection of a decentralised option by the connection of several mini-computers around a more powerful central unit, and of advanced technical equipment, should permit the solution of most of the problems which arose, for several years to come.

8751 Control of turbo-supercharging of gasoline engines. Gusarov, V.V.; Burov, A.L. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 119-123(1977). (In Russian).

A diagram of control of turbo-supercharging of an automobile gasoline engine is considered. Design equations are presented permitting determination of the parameters of the boost control. Data of experimental investigations of a test engine of the ZIL-130 type with controlled turbo-supercharging are presented.

8752 Selection of the parameters of centrifugal limit switches. Shiryaev, M.P. (Plant "Zvezda" im. K.E. Voroshilov, USSR). *Energomashinostroenie;* No. 4, 44-45(1977). (In Russian).

Recommendations are given of the selection of optimal parameters of centrifugal limit switches for diesel engines of the 12ChN18/20 type, which act on throttles stopping air supply to the engine when the latter reaches its limiting rate of revolution.

8753 Mathematical modeling of processes of jet mixture formation in diesels. Lebedev, O.N. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 102-107(1977). (In Russian).

A mathematical model is derived for an unsteady turbulent jet of evaporating atomized fuel. A numerical method is constructed permitting study of the dynamics of formation of the velocity fields of the flow of the medium, concentration of components, as well as the temperature of the steam-and-gas mixture within the fuel-and-air spray.

8754 Engine design series: manifolds. Hartley, J. *Automot. Eng. (London);* **2**: No. 3, 65-67(1977).

A discussion is given of factors to be considered in the design of inlet and exhaust manifolds for automotive internal combustion engines. The effects of manifold design on exhaust gases, performance, and fuel economy are described. Important design criteria are: good air-flow; good distribution between cylinders; pipe lengths designed to take advantage of ram effects; adequate strength to carry the carburetor; suitable heating; and ease of manufacture. (PMA)

EMISSION CONTROL

REFER ALSO TO CITATION(S) 8724

8755 (PB—267571) Tradeoffs associated with possible auto emission standards. Final report 1975. (Environmental Protection Agency, Ann Arbor, Mich. (USA). Mobile Source Pollution Control Program). Feb 1975. 40p. NTIS PC A03/MF A01.

The report has been prepared to provide the Administrator of the EPA with the likely impacts of possible suspension decisions and recommendations to Congress. Impacts considered are those resulting from changes in emission control technology. Included are vehicle cost changes, vehicle fuel economy changes, and unregulated pollutant level changes. For each of the possible decisions and recommendations, the expected direct impacts were determined as a function of time. Five scenarios depict estimated results of five different actions the Administrator may undertake. For each scenario, estimates were made for the type of emission control systems that would be used to meet the standards, the customer first cost of these systems, the fuel economy of a typical car using these control systems and the sulfate emission levels the car would produce. All factors shown are for the 1974 through 1980 model years.

8756 Results of an investigation into the main noise sources of engines. Alekseev, I.V.; Chekryzhov, Yu.G. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 1, 131-134(1977). (In Russian).

Results of experimental investigations into the main noise sources of two-stroke air-cooled engines of the IZh-p4 and IZh-PS type are presented. The most intensive sources of acoustic emission are revealed. Spectra of acoustic power of particular noise sources are presented.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 8762

HYDROCARBONS

8757 Reducing diesel exhaust gas odor. Garrett, K. *Automot. Eng. (London);* **2**: No. 3, 60-61(1977).

Some interesting information was given recently on solutions to the problem of exhaust gas odor with the MAN FM diesel engine modified for stratified charge operation. This appeared in a paper entitled "Present experience with stratified charge engines working with initial separation of mixture components," by Dr. J. Siegfried Meurer of MAN, presented at the conference on stratified charge engines held in London last November by the Institution of Mechanical Engineers. Three measures were found to reduce the exhaust odor emitted by a cold engine idling over an extended period: (1) heating, (2) restricting the air intake, and (3) exhaust recirculation. Of these, the easiest to control is heating the air intake with a burner.

PARTICULATES

8758 (PB—267502) Effects of temperature and fuel lead content on particulate formation in spark ignition engine exhaust. Final report. Sampson, R.E.; Springer, G.S. (Michigan Univ., Ann Arbor (USA). Fluid Dynamics Lab.). Apr 1972. 80p. NTIS PC A05/MF A01.

Experiments were performed to determine the effects of temperature and lead content of the fuel on the weight and size distribution of particulates emitted from a spark ignition engine. The measurements were made using three different, specially constructed sampling systems which utilized filters and an Andersen Sampler for particle collection, and allowed sampling directly from the exhaust stream. The performance of these sampling systems was evaluated, and the conditions necessary for obtaining a representative sample of the exhaust stream were established. Measuring both leaded and unleaded fuels, the total weight of particles emitted using leaded fuel was approximately six times higher than with unleaded fuel. Particulate deposition on the inside of the exhaust system was also evaluated.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 8598

8759 (N—75-17339) Future long-range transports: prospects for improved fuel efficiency. Nagel, A.L.; Alford, W.J. Jr.; Dugan, J.F. Jr. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Feb 1975. 19p. (NASA-TM-X—72659). NTIS.

A status report is provided on current thinking concerning potential improvements in fuel efficiency and possible alternate fuels. Topics reviewed are: historical trends in airplane efficiency; technological opportunities including supercritical aerodynamics, vortex diffusers, composite materials, propulsion systems, active controls, and terminal-area operations; unconventional design concepts, and hydrogen-fueled airplane.

8760 Investigations concerning the realization of normal hydrogen combustion in spark ignition motors by lowering the temperature of residual burnt gases. Vasilescu, C.A.; Ianovici, I.; Soiman, M. *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 1, 135-145(Jan-Mar 1977). (In French).

Elimination of ignition upon admission of an air-hydrogen combustible mixture by the residual hot gases is investigated. The possibility of lowering the temperature of gases in the cylinder by letting in air is presented. The effect of the combustible mixture as a cooling gas as well as the influence of chemical reactions of recirculated burnt gases as a moderator of chemical reactions is examined. Diagrams are presented of test results obtained on an experimental engine to study this type of combustion qualitatively. The investigation shows the advantage of the higher rates of compression and cooling of the residual gases by the introduction of air into the cylinder before letting in fresh mixture.

8761 As the oil begins to run out. Garrett, K. *Automot. Eng. (London);* 2: No. 3, 48-51(1977).

A brief review is given of current thought on alternative automotive fuels and the better utilization of increasingly scarce and costly petroleum-based products. Alternative propulsion systems are considered, including stratified charge spark ignition engines (with fuel injection) and diesel engines. The thermal efficiency and anti-knock ratings for petroleum-based fuels are discussed for these engines. Alternative fuels are characterized: liquefied petroleum gas, methanol, and hydrogen fuels. Production methods and combustion properties of these fuels are delineated. (PMA)

8762 Engine performance and exhaust emission characteristics of spark-ignition engines burning methanol and methanol-gasoline mixtures. Lee, W.; Geffers, W. (Volkswagenwerk, Wolfsburg, Ger). *AIChE Symp. Ser.;* 73: No. 165:, 328-337(1975).

Engine dynamometer tests and road tests using pure methanol, methanol-gasoline blend (15 vol.% methanol plus 85 vol. % gasoline) called M 15 blend, and commercial gasoline were made. The results showed that, in principle, from technological aspects it is possible to use methanol as a gasoline extender or as methanol/gasoline blends for automobiles. With regard to energy consumption, methanol and methanol/gasoline blend (M 15) lead to interesting results. But the fuel economy benefit of using M 15 was found to be just in the part-throttle operation of a 1975 car. The emission characteristics except aldehyde emission and unburnt methanol are improved by using pure methanol, a considerable reduction in NO/ sub x/ by using pure methanol, in CO by using M 15, and in PNA by using both. The potential problems are cold start and unacceptable drivability in the warm-up phase when using pure methanol and vapor lock in summer and phase separation in winter when using a methanol/gasoline blend (M 15). Some solutions are discussed.

MATERIALS

8763 (SAND—77-1237C) **Materials compatibility information data bank.** Mead, K.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 10p. (CONF-771012—1). Dep. NTIS, PC A02/MF A01.

From 5. ERDA compatibility meeting; Miamisburg, Ohio, USA (4 Oct 1977).

A major concern in the design of weapons systems is the compatibility of the materials used with each other and with the enclosed environment. Usually these systems require long term storage with a high reliability for proper function at the end of this storage period. Materials selection is then based on both past experience and laboratory accelerated aging experiments to assure this long term reliability. To assist in the task of materials selection a computerized materials compatibility data bank is being established. This data bank will provide a source of annotated information and references to personnel and documents for both the designer and materials engineer to draw on for guidance in materials selection. The data bank storage and information retrieval philosophy will be discussed and procedures for information gathering outlined. Examples of data entries and search routines will be presented to demonstrate the usefulness and versatility of the proposed system.

8764 **Nondestructive technique for the measurement of fast diffusion.** Kim, K.K.; Mundy, J.N.; Puri, S.M. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **48**: No. 12, 1628-1631(Dec 1977).

A nondestructive technique is described that measures diffusivity of fast-diffusing atoms to an accuracy of 1%. The technique utilizes coincidence counting of γ rays emitted in opposite directions when a positron annihilates with an electron. The application of the method is discussed.

METALS AND ALLOYS

PREPARATION AND FABRICATION

8765 (AD-A—040336) **Nickel composite magnetostrictive material research for ultrasonic transducer. Final report.** Peters, D.T.; Huston, E.L. (International Nickel Co., Inc., New York (USA)). Jan 1977. Contract N00039-76-C-0017. 42p. NTIS PC A03/MF A01.

The immediate objective was to manufacture and test a composite transducer material of the compound $SmFe_2$ in a nickel matrix fabricated by a powder metallurgy technique. The long term objective was the effective utilization of a 'giant' magnetostrictive $REFe_2$ material in a ductile and corrosion resistant composite for use as a transducer core material.

8766 (AD-A—040361) **Analysis of semiconductor structures by nuclear and electrical techniques. Interim technical report.** Harris, J.M.; Lau, S.S.; Mayer, J.W.; Nicolet, M.A.; Olowolafe, J.O. (California Inst. of Tech., Pasadena (USA). Dept. of Electrical Engineering). Jan 1977. Contract F19628-75-C-0008. 54p. NTIS PC A04/MF A01.

MeV backscattering spectrometry and x-ray diffraction are used to investigate the behavior of sputter-deposited Ti-W mixed films on Si substrates. During vacuum anneals at temperatures of 700 C for several hours, the metallization layer reacts with the substrate. Backscattering analysis shows that the resulting compound layer is uniform in composition and contains Ti, W and Si. The Ti:W ratio in the compound corresponds to that of the deposited metal film. X-ray analyses with Read and Guinier cameras reveal the presence of the ternary Ti/sub x/W/sub 1-x/Si_2 compound. Its composition is unaffected by oxygen contamination during anneal, but the reaction rate is affected. The rate measured on samples with about 15% oxygen contamination is linear, of the order of 0.5 A/sec at 725 C, and depends on the crystallographic orientation of the substrate and the dc bias during sputter deposition of the Ti-W film.

8767 (LBL—6622) **Investigation of hydrostatic extrusion and other deformation modes for the fabrication of multifilamentary niobium—tin superconductors by a powder metallurgy approach.** MacLeod, G.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1977. Contract W-7405-ENG-48. 55p. Dep. NTIS, PC A04/MF A01.

Various aspects of a powder metallurgy approach to fabricate filamentary niobium-tin superconducting wire were investigated. Difficulties occurred due to lack of complete tin infiltration of the sintered niobium rod, formation of intermetallics during infiltration, and both cladding and core fracture during mechanical reduction. The influence of sintering time, infiltration temperature, and deformation mode was investigated. Progress is reported on the clarification of the role of several of the important process parameters.

8768 (N—77-22213) **Development of oxide dispersion strengthened turbine blade alloy by mechanical alloying.** Merrick, H.F.; Curwick, L.R.; Kim, Y.G. (International Nickel Co., Inc., Suffern, N.Y. (USA). Paul D. Merica Research Lab.). Jan 1977. Contract NAS3-19694. 69p. (NASA-CR—135150). NTIS PC A04/MF A01.

There were three nickel-base alloys containing up to 18 wt. % of refractory metal examined initially for oxide dispersion strengthening. To provide greater processing freedom, however, a leaner alloy was finally selected. This base alloy, alloy D, contained 0.05C—15Cr — 2Mo—4W—2Ta—4.5Al—2.Ti—015Zr—0.01-B—Bal. Ni. Following alloy selection, the effect of extrusion, heat treatment, and oxide volume fraction and size on microstructure and properties were examined. The optimum structure was achieved in zone annealed alloy D which contained 2.5 vol. % of 35 mm Y_2O_3 and which was extruded 16:1 at 1038 C.

8769 (N—77-24254) **High toughness-high strength iron alloy.** Stephens, J.R.; Witzke, W.R. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 6 Jun 1977. 12p. NTIS PC A02/MF A01.

A steel alloy is provided which exhibits excellent strength and toughness characteristics at cryogenic temperatures. The alloy consists essentially of about 10 to 16 percent by weight nickel, about 0.1 to 1.0 percent by weight aluminum, and 0 to about 3 percent by weight of at least one of the following additional elements: copper, lanthanum, niobium, tantalum, titanium, vanadium, yttrium, zirconium and the rare earth metals, with the balance being essentially iron. The steel alloy is produced by a process which includes using cold rolling at room temperature and subsequent heat treatment at temperatures ranging from 500 to 650 C, and possesses a fracture toughness ranging from 200 to 230 ksi and yield strengths up to 230 ksi.

8770 **Influence of the condition of the reflecting surface of an yttrium—erbium alloy on the character of the dispersion function of high-frequency conductivity.** Beznosov, A.B.; Gnezdilov, V.P.; Eroshenko, V.B.; Zvyagina, N.M.; Nikolskii, G.S. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 579-580(May 1977).

The preparation of the surfaces of Yb-Er alloys for metallographic investigation is studied with emphasis on film deposition techniques.(AIP)

8771 **Sintering mechanisms in the 95% W—3.5% Ni—1.5% Fe composite.** Zukas, E.G.; Sheinberg, H. (Los Alamos Scientific Lab., NM). *Powder Technol.;* **13**: 85-96(1976).

The growth rate of the pure tungsten spheroids during liquid-phase sintering of the 95% W—3.5% Ni—1.5% Fe composite was studied as a function of either time or temperature. The generally accepted theory for such growths proposes the dissolution of the small spheroids with simultaneous precipitation of tungsten from the molten matrix onto the larger spheroids, the reaction being driven by the difference in surface energy between the large and small spheroids. The results from our studies are inconsistent with such a theory in that the log diameter-log time plot does not have a slope of $\frac{1}{3}$, and rates of growth at different sintering temperatures cannot be described by a single activation energy. Probably, several growth mechanisms are active simultaneously, with spheroid coalescence being an important growth mechanism during all stages of sintering.

8772 **Problems in the welding of nuclear [reactor] components.** Di Teodoro, L.; Gatti, G.M. *Riv. Ital. Saldatura;* **27**: No. 6, 359-373(1975). (In Italian).

The problem of stress-relief cracking (SRC) in the heat-affected zone of welds in thick-walled reactor components is discussed, together with the occurrence of SRC in clad plates. Details are given of test programmes carried out to evaluate factors contributing to the occurrence of SRC, and operating procedures to eliminate it. An ultrasonic technique to locate SRC in clad panels is described, together with a procedure of continuous induction heat treatment to anneal heat-affected weld zones without producing SRC.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 8768

8773 **Electronic structure and reentrant magnetism in superconducting $ErRh_4B_4$.** Jarlborg, T.; Freeman, A.J.; Watson-Yang, T.J. (Department of Physics, Chalmers University of Technology, S-402 20 Gothenburg, Sweden). *Phys. Rev. Lett.;* **39**: No. 16, 1032-1034(17 Oct 1977).

Results of ab initio self-consistent energy-band calculations on the full 18-atom/unit-cell ternary alloys MRh_4B4 (M = Y, Er and Ho) are reported and used to discuss their superconducting and magnetic properties—including the observation of reentrant magnetism in the normal state at $T < 0.9$ K in $ErRh_4B_4$.

8774 **Theory of an obstacle-controlled yield strength: report after an international workshop.** Kocks, U.F. (Argonne National Lab., IL). *Mater. Sci. Eng.;* **27**: 291-298(1977).

From May 29 to June 1, 1976, a workshop was held at Argonne National Laboratory to consider and assess the current status of the theory of strengthening mechanisms--insofar as these are controlled by fixed obstacles of limited extent in the slip plane, such as precipitates, solute atoms, and possibly forest dislocations. (Excluded were the lattice resistance, long-range stresses, effects of grain boundaries and the like.)

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 7951, 8352, 8480, 8487, 8510, 8769

8775 (AD-A—041284) **Lockalloy Be—38Al material characterization, 1976 year-end report.** Sullivan, J.F.; Haramis, A.C. (Lockheed-California Co., Burbank (USA)). 10 May 1977. 106p. (LR—28051). NTIS PC A06/MF A01.

Lockalloy, Be-38Al, is a beryllium-aluminum composite material originally developed by LMSC. The potential use of Lockalloy as a structural material is emphasized for applications on Hypersonic Flight Vehicles or other installations requiring high stiffness to weight ratios, high heat conductivity and/or high specific heat. This year-end report documents the results to date of a testing program to establish further the characteristics of Lockalloy material. The testing was performed by Advanced Design Projects (ADP) personnel. These tests involved experimental and analytical studies conducted to obtain additional information regarding basic Be-38Al Lockalloy material properties and characteristics. The studies provide data regarding impact strength, resistance to stress corrosion, response to post-manufacturing thermal treatment, weldability, and inspectability. The accuracy of methods for determining the modulus of elasticity and predicting compression instability (column strength) were also verified. In addition, the behavior of this material in certain structural concepts considered for the X-24C airplane was evaluated.

8776 (IEA—451) **Mechanical properties of aluminium-uranium alloy and aluminium commercially pure at several temperatures.** de Quadros, N.F. (Instituto de Energia Atomica, Sao Paulo (Brazil). Divisao de Metalurgia Nuclear). Dec 1976. 18p. (In Portuguese). (CONF-7506174—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Annual congress of the Brazilian Association of Metals; Rio de Janeiro, Brazil (20 Jun 1975).

The mechanical properties of Ai-U (18,4 wt %) alloy with and without heat treatment were determined, and they were compared with the mechanical properties of aluminum alloy of commercial purity, AI-1100, at tempiratures of 25, 500, 550 and 600°C, the changes of both the yield point stress and the ultimate tensile strength as a function of temperature may be described through two emperical relationships. A fractography study was also made.

8777 (JEN—363) **Creep-rupture-strength and creep-behaviour of stainless steel X6CrNi 1811 (DIN 1.4948).** Solano, R.R.; de las Rivas, M.; Seith, B.; Schirra, M. (Junta de Energia Nuclear, Madrid (Spain)). 1977. 25p. (In Spanish). Dep. NTIS (US Sales Only), PC A02/MF A01.

The steel X6CrNi 1811 (DIN 1.4948) that will be used as a structure material for the German fast breeder reactor SNR 300, was creep-tested in a temperature range of 550-650 deg C under base material condition as well as welded material condition. Tests are foreseen up to 30.000 hours with a continous measuring of the elongation. The test results up to about 4.000 hours are described. Taking into account the results of other programs carried out with the same material between 550 and 600 deg C at similar rupture time, the stresses were defined for the longterm test. The main point of this program ("Extrapolation Program") lies in the knowledge of the creep-rupture-strength and creep behaviour of the structure materials up to 3.10^4 h at high temperature in order to extrapolate up to 10^5 h for reactor operating temperatures.

8778 (N—77-22180) **Tensile and compressive test results for metal matrix composites. Interim report.** Shuart, M.J.; Herakovich, C.T. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Coll. of Engineering). Feb 1977. Contract NGR-47-004-129. 50p. (NASA-CR—152697; VPI-E—77-6). NTIS PC A03/MF A01.

Experimental results of the mechanical behavior of two metal matrix composite systems at room temperature are presented. Ultimate stress, ultimate strain, Poisson's ratio, and initial Young's Modulus are documented for BORSIC/Aluminum in uniaxial tension and Boron/Aluminum in uniaxial tension and compression. Poisson's ratio is used for nonlinear stress-strain behavior. A comparison of compression results for B/Al as obtained from sandwich beam compression specimens and IITRI coupon compression specimens is presented.

8779 (N—77-22215) **Carburization and heat treatment to cause carbide precipitation in gamma/gamma prime-delta eutectic alloys.** Tewari, S.N.; Dreshfield, R.L. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). May 1977. 19p. (NASA-TM-X—3518; E—8976). NTIS PC A02/MF A01.

In an attempt to improve their longitudinal shear strength, several directionally solidified eutectic alloy compositions with minor element modifications were pact, carburized, and heat treated to provide selective carbide precipitation at the cell and grain boundaries. The directionally solidified Ni-17.8Nb-6Cr-2.5Al-3Ta (weight percent) alloy was selected for the shear strength evaluation because it showed the shallowest delta-denuded zone at the carburized surface. The carburization-carbide precipitation treatment, however, did not appear to improve the longitudinal shear strength of the alloy.

8780 (N—77-22531) **Evaluation of coated columbium alloy heat shields for space shuttle thermal protection system application. Final report.** Black, W.E. (General Dynamics/Convair, San Diego, Calif. (USA)). Apr 1977. Contract NAS1-9793. 67p. (NASA-CR—2824; CASD-NAS—76-056). NTIS PC A04/MF A01.

A three-phase program to develop and demonstrate the feasibility of a metallic heat shield suitable for use on Space Shuttle Orbiter class vehicles at operating surface temperatures of up to 1590 K (2400 F) is summarized. An orderly progression of configuration studies, material screening tests, and subscale structural tests was performed. Scale-up feasibility was demonstrated in the final phase when a sizable nine-panel array was fabricated and successfully tested. The full-scale tests included cyclic testing at reduced air pressure to 1590 K (2400 F) and up to 158 dB overall sound pressure level. The selected structural configuration and design techniques succesfully eliminated thermal induced failures. The thermal/structural performance of the system was repeatedly demonstrated. Practical and effective field repair methods for coated columbium alloys were demonstrated. Major uncertainties of accessibility, refurbishability, and durability were eliminated.

8781 **Inelastic deformation of pressurized stainless steel tubes under dynamic bending and torsional loading.** Larson, L.D.; Stokey, W.F. (Westinghouse Electric Corp, West Mifflin, Pa). *J. Pressure Vessel Technol.;* **99**: No. 2, 258-263(May 1977).

Paper No 76-PVP-24.

8782 **Effect of oxygen on the strength and ductility of polycrystalline vanadium in the range of 4.2 to 400 K.** Carlson, O.N.; Alexander, D.G.; Elssner, G. (Ames Lab., IA). *Metall. Trans., A;* **8**: 99-104(Jan 1977).

The effect of oxygen on the yield stress and ductility of polycrystalline vanadium was investigated for concentrations of 0.004 to 1.25 at pct oxygen over the temperature range of 4.2 to 400 K. The dependence of the resolved shear stress on temperature and composition was tested against the different interstitial solute strengthening theories. A parabolic dependence of tau on concentration was found to hold in the low solute concentration range and a linear dependence was observed at high oxygen concentrations. A statistical model proposed by Labusch gives a good description of the concentration dependence of the shear stress for the entire temperature-composition range investigated. This correlation suggests that a spectrum of defects may be contributing to the strengthening of vanadium-oxygen alloys. The combined effects of oxygen content and temperature on the strain hardening exponent and reduction in area was investigated. Alloys containing 0.83 at. pct or less do not exhibit a brittle-ductile transition down to 4.2 K but a 1 at. pct alloy is brittle at 77 K and a 1.25 at. pct alloy has a BDTT between 135 and 195 K.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 8800, 9075, 9483

8783 (ORNL—5171, pp 143-157) **Liquid and surface physics.** Birkoff, R.D.; Allen, J.D.; Hamm, R.N.; Heller, J.M. Jr.; Hubbell, H.H. Jr.; MacRae, R.A.; Painter, L.R.; Spears, D.P. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Liquid and surface physics research is covered. Areas include: surface potentials by electron scattering; pinhole electron gun for electron scattering studies; the Schroedinger equation can be solved exactly. (DLC)

8784 (ORNL—5171, pp 158-172) **Physics of solids and macromolecules.** Arakawa, E.T.; Anderson, V.E.; Baird, J.K. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Research into the physics of solids and macromolecules is reported. Topics covered include: optical properties of liquid sodium from ellipsometric measurements; photoemission from thick samples;

electron attenuation lengths in the vacuum ultraviolet and soft x-ray regions; polarizability and effective radius of macro-molecular ions in aqueous solution; solar energy collectors; artificial grating anomalies from holographic gratings; holographic gratings; blazing of holographic gratings by use of surface waves; holography with optical guided waves; and imaging with optical guided waves. (GHT)

8785 (SAND—77-0626C) **Thermal expansion of molten materials by the gamma attenuation technique.** Drotning, W.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 20p. (CONF-770843—1). Dep. NTIS, PC A02/MF A01.

From International thermal expansion symposium; Winnipeg, Canada (29 Aug 1977).

An apparatus was constructed for measurement of the density and volumetric thermal expansion of high temperature molten materials using the gamma attenuation technique. It was found that significant improvements in overall experimental precision could be realized by employing an automatic gain control in the linear section of the gamma counting system. This device reduced errors due to system gain shifts and thereby increased the precision of the gamma counting. Corrections were also made for the dead time of the electronics system. A preliminary experimental investigation of the precision of the method was made by measuring small dimensional steps of a tool steel block at a single temperature. A fractional length increment $\Delta l/l$ of 1% was determined to 1%, equivalent to a length change precision of 10^{-4} cm/cm. In addition, the precision of the experimental technique was analytically examined for both absolute and relative density determinations. Three analytical expressions used to reduce data for liquid density determinations were evaluated for their precision. Each allows use of a different set of input data parameters, which can be chosen based on experimental considerations. Using experimentally reasonable values for the precision of the parameters yields a similar resultant density precision from the three methods, on the order of 0.2%.

8786 **High-field critical current in in situ multifilamentary Cu-Sn-Nb alloys.** Foner, S.; McNiff, E.J. Jr.; Schwartz, B.B.; Roberge, R.; Fihey, J.L. (Francis Bitter National Magnet Laboratory and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **31**: No. 12, 853-854(15 Dec 1977).

High-field properties of improved in situ Cu-Sn-Nb alloys are presented. Values of critical current densities of 10^5 A/cm^2 and a resistivity of less than 2×10^{-13} Ω cm are observed at 12 T. Critical current densities for various in situ alloys are presented for fields to 18 T.

8787 **Measurement of B versus H of Alumel from 25 to 180 °C.** Horton, J.L.; Kollie, T.G.; Rubin, L.G. (Instrumentation and Controls Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **48**: No. 11, 4666-4671(Nov 1977).

The relationship between the magnetic induction B and the magnetic field H in Alumel was measured by the ring method for temperatures T between 25 and 180 °C. These data were needed to correct for large temperature measurement errors that occurred when Chromel-vs-Alumel thermocouples were used in a magnetic field. Through application of the Weiss equation, the saturation value of the intrinsic magnetic induction B/sub s/ was calculated as a function of T from the experimental B-vs-T data. Weiss's method was used to determine the Curie temperature of Alumel, T/sub c/ ≈152 °C, from a plot of B^2/sub s/ versus T near T/sub c/. The experimental values of B/sub s/ versus T were in good agreement with those obtained from the Brillouin function with quantum number J = 1/2.

8788 **Measurements of gap anisotropy in A15 Nb_3Sn.** Gurvitch, M.; Ghosh, A.K.; Snead, C.L. Jr.; Strongin, M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 17, 1102-1104(24 Oct 1977).

A recent suggestion by Farrel and Chandrasekhar that a major part of the critical-temperature (T/sub c/) reduction in A15 superconductors, caused by radiation-induced defects, is a manifestation of a large gap anisotropy is examined for Nb_3Sn. Electron-irradiation data show that the T/sub c/ changes with damage are inconsistent with a large gap anisotropy. However, if one assumes that the initial changes in T/sub c/ with fluence are indeed due to gap anisotropy, then it is shown that the anisotropy parameter $< a^2 >$ for Nb_3Sn is 9 or ≈ 0.03.

8789 **Electron-phonon contribution to the phonon linewidth in Nb: Theory and experiment.** Butler, W.H.; Smith, H.G.; Wakabayashi, N. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **39**: No. 16, 1004-1007(17 Oct 1977).

We present theoretical calculations and experimental measurements of the phonon linewidth for Nb. The calculations employ the rigid muffin-tin approximation and a realistic band structure. The measurements were done at low temperature to minimize the contributions to the linewidth from phonon-phonon interactions. The calculations predict and experiments confirm strong electron-phonon coupling for the longitudinal phonon modes in the [110] direction.

8790 **Pressure dependence of magnetic excitations in PrSb.** Vettier, C.; McWhan, D.B.; Blount, E.I.; Shirane, G. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev. Lett.;* **39**: No. 16, 1028-1031(17 Oct 1977).

Inelastic-neutron-scattering studies show triple degeneracy of the Γ_1-Γ_4 exciton along [111] and double degeneracy along [100] with a band-structure-related softening of the longitudinal branch at X. The Γ_1-Γ_4 and Γ_4-Γ_5 transitions decrease with increasing pressure suggesting the occurrence of a pressure-induced soft-mode magnetic transition.

8791 **Anomalous transport properties of a linear-chain metal: $NbSe_3$.** Ong, N.P.; Monceau, P. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., B;* **16**: No. 8, 3443-3455(15 Oct 1977).

The transport properties of the linear-chain metal $NbSe_3$ are anomalous. Giant increases in the dc resistivity appear at 145 and 59 K, suggestive of charge-density-wave (CDW) formation. These anomalies show breakdown effects with applied electric fields as low as 0.1 V cm^{-1}. The temperature dependence of the resistivity also shows strong variation at microwave frequencies. We report measurements on the temperature dependence of the non-Ohmic effect together with microwave results and review the evidence for CDW formation. On the basis of the CDW model we have extracted a parameter α from the data which gives the fraction of the Fermi surface destroyed by the CDW gap. Other models are discussed and compared with the CDW model. We consider the possibility that the anomalous conductivity may arise from nonlinear excitations of a pinned CDW.

8792 **Specific heats of Li, Na, K, and Ag β-alumina below 1 K.** Anthony, P.J.; Anderson, A.C. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev., B;* **16**: No. 8, 3827-3828(15 Oct 1977).

Specific-heat measurements of Li, Na, K, and Ag β-alumina in the temperature range 0.1-1 K confirm the existence of a broad spectrum of localized low-energy excitations.

8793 **Effect of pressure on the Fermi surface and band structure of ferromagnetic Gd. I. Experiment.** Schirber, J.E.; Schmidt, F.A.; Harmon, B.N.; Koelling, D.D. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., B;* **16**: No. 7, 3230-3233(1 Oct 1977).

We report measurements of the effect of pressure on eight cross sections of the Fermi surface of ferromagnetic Gd. Cross sections were obtained from de Haas—van Alphen effect measurements on a spherical crystal cut from a boule refined by electrotransport to a residual resistivity ratio of ~260. Pressure derivatives were determined using both fluid-He and solid-He techniques. The results show a surprising variation in both sign and magnitude in view of the near isotropy of the linear compressibilities of Gd. An electron transition involving the disappearance of a cross section of the Fermi surface near 8 kbar is indicated.

8794 **Heat capacity of tantalum with rapid pulsed heating by a high-density electric current.** Lebedev, S.V.; Mozharov, G.I. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 45-48(Jul 1977).

An investigation was made of the heat capacity of tantalum in the solid and liquid states with rapid pulsed heating by a high-density current, assuring a rate of rise in the temperature of 10^8-10^9 deg K/sec. With such heating, the heat capacity of tantalum in the solid state considerably exceeded the corresponding equilibrium data near the melting point T/sub mt/. In the region of temperatures up to ≈0.9T/sub mt/, the results of measurement of the heat capacity coincided with the equilibrium. The temperature was measured using a model of an absolutely black body.

8795 **Average thermal-expansion coefficient of the tungsten—niobium system.** Zaichenko, V.I.; Chekhovskoi, V.Y. (High-Temperatures Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 49-52(Jul 1977).

The average thermal-expansion coefficient of a series of tungsten—niobium alloys was studied at 500-1200°K over the range 0-30 at.% Nb. The concentration dependence of the average thermal expansion coefficient exhibited a bend in the region of ~15 at.% Nb. This change in the thermal-expansion coefficient in the solid-solution region of the binary phase diagram indicated the existence of a specific phase transformation within the concentration range studied. Identification of this transformation will require further independent investigations.

8796 **Experimental investigation of thermal expansion of structural materials. Molybdenum and molybdenum alloy VN-2M.** Petukhov, V.A.; Chekhovskoi, V.Y.; Mozgovoi, A.G. (High-Temperature

Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 175-178(Jul 1977).

The temperature dependence of the average coefficient of linear expansion of Mo and Mo alloy VN-2M were measured in the range 971—2153°C by the optical comparator method. (AIP)

8797 Anomalies of the heat capacity of neodymium and praseodymium at high temperatures. Maistrenko, L.G.; Polovov, V.M. (Institute of Solid State Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 150-151(Jan 1977).

The heat capacity of ~99.6% pure polycrystalline Nd and Pr samples was measured in the interval 300—850 K. λ-anomalies of the heat capacity, corresponding to the known anomalies of the thermal expansion, were observed at 700 K (Pr) and 773 K (Nd).

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 7819, 7820, 7833, 8352, 8621, 8775

8798 (N—77-21214) **The stress corrosion resistance and the cryogenic temperature mechanical properties of hot-rolled Nitronic 32 bar material.** Montano, J.W. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Apr 1977. 24p. (NASA-TM-X—73375). NTIS PC A02/MF A01.

The ambient and cryogenic temperature mechanical properties and the ambient temperature stress corrosion properties of hot rolled and centerless ground Nitronic 32 stainless steel bar material are presented. The mechanical properties of longitudinal specimens were evaluated at test temperatures from ambient to liquid hydrogen. The tensile test data indicated increasing smooth tensile strength with decreasing temperature to liquid hydrogen temperature. However, below -200 F (-129.0 C) the notched tensile strength decreased slightly and below -320 F (-196.0 C) the decrease was significant. The elongation and reduction of area decreased drastically at temperatures below -200 F (-129.0 C). The Charpy V-notched impact energy decreased steadily with decreasing test temperature. Stress corrosion tests were performed on longitudinal tensile specimens stressed to 0, 75, and 90 percent of the 0.2 percent yield strength and on transverse 'C'-ring specimens stressed to 75 and 90 percent of the yield strength and exposed to alternate immersion in a 3.5 percent NaCl bath, humidity cabinet environment, and a 5 percent salt spray atmosphere. The longitudinal tensile specimens experienced no corrosive attack; however, the 'C'-rings exposed to the alternate immersion and to the salt spray experienced some shallow etching and pitting, respectively. Small cracks appeared in two of the 'C'-rings after one month exposure to the salt spray.

8799 (N—77-21216) **Susceptibility to hot corrosion of four nickel-base superalloys, NASA-TRW VIA, B-1900, 713C and IN-738.** Stearns, C.A.; Kohl, F.J.; Fryburg, G.C. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Apr 1977. 19p. (NASA-TN-D—8461; E—8977). NTIS PC A02/MF A01.

The susceptibility to hot corrosion of four nickel-base, cast superalloys has been studied at 900 and 1000 C. The test consisted of coating alloy samples with known amounts of Na_2SO_4 and oxidizing the coated samples isothermally in 1 atmosphere of slowly flowing oxygen, the weight-gain being monitored on a sensitive recording microbalance. Susceptibility to hot corrosion decreased in the order of decreasing molybdenum content of the alloys. Preoxidation of samples before hot-corrosion testing markedly increased the induction period observed prior to the inception of hot corrosion for all alloys tested. X-ray diffraction analyses of the oxide scales were made. All samples that underwent hot corrosion showed the presence of a $(Ni,Co)MoO_4$ layer near the alloy-oxide interface. Several specimens displayed resistance to hot corrosion and these showed $NaTaO_3$ as a prominent feature in their oxide scale. Our results may be interpreted as indicating that molybdenum in an alloy is detrimental, with respect to hot corrosion, while tantalum is beneficial.

8800 (TRG-Report—2949(R)) **Corrosion monitoring of SGHWR pressure tubes.** Sheppard, M.F.; Tyzack, C. (UKAEA Reactor Group, Risley). Mar 1977. 25p. (CONF-760858—3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Symposium on zirconium nuclear industry; Quebec, Canada (10 Aug 1976).

A range of Zirconium alloy materials representing all Winfrith SGHWR pressure tube manufacturing routes, also fuel cladding, etc. has been irradiated in the coolant for periods up to 531 effective full power days (EFPD). Weight gains generally show a reasonable linear correlation with the fast fluences to which they have been exposed. The metallurgical history affects the corrosion rate; a quench treatment at the billet stage seems to be beneficial. Metallographic examination shows the presence of nodular corrosion on many materials; the extent of this generally follows weight gain patterns. A discussion on mechanistic aspects of nodular corrosion is included. Hydrogen uptake by the specimens is small, and appears to be indepedent of corrosion weight gain. Extrapolation of results to the expected full reactor life indicates that neither loss of section by corrosion nor hydrogen pick-up by the pressure tube should be life-limiting.

8801 Corrosion protection of steel in water supply engineering. van Oeteren, K.A. *Brunnenbau. Bau Wasserwerk. Rohrleitungsb.;* **27**: No. 7, 245-251(Jul 1976). (In German).

3 figs.; 4 tabs.

The article gives a survey of the mechanical stresses and types of corrosion of steel in water supply engineering and of possible ways to prevent these.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 8788, 9477

8802 Defect clusters and annealing in self-ion-irradiated nickel. Narayan, J.; Larson, B.C. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **48**: No. 11, 4536-4539(Nov 1977).

Transmission electron microscopy and x-ray diffuse scattering have been used to study defect clusters in 4-MeV self-ion-irradiated (total doses of 2.5 x 10^{13} and 5.0 x 10^{13} ions/cm^2) nickel. The distribution of defect clusters as a function of the ion penetration depth was measured directly in the electron microscope using a transverse sectioning technique. For an ion dose of 2.5 x 10^{13} cm^{-2}, the average cluster radius of 32 +- 2 A at the damage peak depth (0.82 μm) was 20% larger than the average radius near the crystal surface. The fraction of point defects created in the displacement cascades that survived in the form of defect clusters was found to be about 1% for these doses. Annealing at 125, 250, and 450 °C gave a monotonic decrease in the number of point defects stored in the form of loops.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 8065, 8066, 8067, 8069, 8070

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 8359, 8360, 8774

8803 Analyzing hydrogen with nuclear reactions. Picraux, S.T. (Sandia Laboratories, Albuquerque). *Phys. Today;* **30**: No. 10, 42-51(Oct 1977).

Nuclear-reaction techniques for determining depth profiles of hydrogen, deuterium and tritium are of value in solar-cell manufacture and metallurgical problems such as steel embrittlement and radiation damage.

8804 Functional-derivative study of the Hubbard model. I. Perturbation method and first-order approximation. Arai, T.; Cohen, M.H.; Tosi, M.P. (Argonne National Lab., IL). *Phys. Rev., B;* **15**: No. 4, 1817-1835(15 Feb 1977).

In order to study the properties of the Hubbard model for narrow bands, a systematic treatment of the equations of motion of the Green's functions appropriate to that model has been developed. Higher-order Green's functions are reduced to functional derivatives of the basic Green's function G and calculated iteratively in a perturbation scheme which takes the Hubbard I solution G_0 as the zeroth-order Green's function. A zeroth-order approximation to the self-energy correction obtained by inserting G_0 into the functional derivatives is compared with various existing solutions. The perturbation scheme is further extended to an infinite order and the self-energy is calculated exactly up to terms linear in the hopping motion ϵ, a result which has not been obtained previously. The self-energy correction in this final result is drastically different from the zeroth-order solution, demonstrating the importance of the infinite-order iterative procedure. Finally, the electron correlations included in the final result are discussed in terms of diagrams.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 7816, 7817, 7832

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 8516, 8784, 8785

8805 Resistivity of shock-wave-compressed PZT 95/5. Lysne, P.C. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **48**: No. 11, 4565-4568(Nov 1977).

A model is developed that takes into account the finite resistivity of ferroelectric ceramics compressed by shock waves propagating in a direction perpendicular to the remanent polarization vector. This model is fit to data obtained from experiments on Pb/sub 0.98/Nb/sub 0.02/(Zr/sub 0.95/Ti/sub 0.05/)/sub 0.98/O_3 (referred to as PZT 95/5). The resistivity of this material in the stress range 1.6—3.2 GPa is about 7×10^4 Ω cm.

8806 EPR studies of the valence states of thulium in thulium monochalcogenides. Huang, C.Y.; Sugawara, K. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico). *J. Low Temp. Phys.;* **28**: No. 3, 229-239(Aug 1977).

We have studied the Gd^{3+} EPR at 9.2 HGz in 0.1 at % GdS in TmS, 1 at % GdTe in TmTe, and 1 at % GdSe in TmSe. From the temperature dependence of the Gd^{3+} linewidth we have concluded that Tm in TmS is trivalent. The temperature variation of the Gd^{3+} linewidth in TmTe has been interpreted as the result of the "delocalization" of the extra electron "localized" around Gd^{3+}. The g-value and linewidth data are consistent with the identification that Tm in TmTe is divalent. The linewidth and the g-value of the Gd^{3+} resonance in the TmSe have been found to be temperature independent. These striking results have been attributed to the "motional narrowing" effect arising from valence fluctuations of Tm in TmSe.

8807 Switching in the VO_2—dielectric—semiconductor system. Vasil'ev, G.P.; Serbinov, I.A.; Ryabova, L.A. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 4, 139-140(Apr 1977).

The effect of a transverse electric field on the semiconductor metal phase transition and the switching in VO2 films is studied. The films were produced by pyrolysis.(AIP)

8808 Computer simulation of sodium diffusion in β″-alumina. Murch, G.E.; Thorne, R.J. (Argonne National Lab., IL). *Philos. Mag.;* **35**: No. 2, 493-502(1977).

The correlation factor, f, the vacancy availability factor, V, and the jump frequency factor, W, for dissusion of sodium ions in β″-alumina were calculated as functions of composition and temperature through the application of a Monte Carlo method to a model of nearest-neighbor interactions. The results for V and W are in good agreement with those obtained from the pair approximation to the path probability method of Sato and Kikuchi (1971), but results for f are in substantial disagreement because the calculations of these authors do not include the mathematics of the ordered region. 5 figures.

8809 Chemisorption, photodesorption, and conductivity measurements on ZnO surfaces. Shapira, Y.; Cox, S.M.; Lichtman, D. (Univ. of Wisconsin, Milwaukee). *Surf. Sci.;* **54**: 43-59(1976).

Experimental results of a mass-spectrometric analysis of photodesorption from ZnO single crystals at different temperatures are reported. They provide direct evidence that CO_2 is the only photodesorbed species from both the single crystal and powder samples studied. The CO_2 photodesorption occurs only when the incident photon energy exceeds the ZnO band gap energy. In addition, measurements of the chemisorption kinetics of oxygen on ZnO single crystal and powder surfaces are reported. The results are compared with CO_2 and CO chemisorption experiments to show that, of these gases, only oxygen chemisorbs from the gas phase. Auger analysis of oxygen saturated and photodesorbed surfaces of ZnO show a significant relation between the carbon content and the photodesorptive and conductive activities of those surfaces. These observations indicate that impurity carbon atoms on ZnO surfaces can be oxidized by electron capture to produce chemisorbed CO_2^- "ion-molecules" which will then readily photodesorb by bandgap radiation. This proposed process is discussed together with further supporting evidence.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 8370, 8371, 8410

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 8362, 8363, 8364, 8365, 8366, 8368, 8369, 8381, 8412, 8803

COMPOSITE MATERIALS

STRUCTURE AND PHASE STUDIES

8810 (KFK—2375, pp 415-439) **Constitution and reaction behaviour of LWR materials at core-melting conditions.** Hofmann, P.; Holleck, H.; Politis, C.; Skokan, A. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Nov 1976. (In German).

In First semiannual report, 1976.

Phase equilibrium studies: Experimental investigations were performed at 1000, 1500 and 2000°C in the section UO_2-α-Zr(0)-Fe. Reaction studies: Corium E and Corium A samples with and without fission products as well as completely oxidized Corium E were melted down under different experimental conditions. The interaction of Corium with concrete (silicate) was studied in argon, varying the compostion of Corium and the mixing ratio Corium/concrete. Metallurigical examinations of molten rods: Phase analytical studies on simulated LWR-rods, heated up in air and water vapor up to 2000°C were performed.

MECHANICAL PROPERTIES

8811 (N—77-21194) **Results of boron—aluminum thrust structure. Interim report.** Hyer, M.W.; Lightfoot, M.C. (Old Dominion Univ., Norfolk, Va. (USA). Research Foundation). Dec 1976. 42p. (NASA-CR—146973). NTIS PC A03/MF A01.

Results are presented of testing-to-failure a two member boron-aluminum thrust structure. The structure represented one section of a more complex planar truss and was designed to test the integrity of a diffusion bonded joint. The structure failed at 107 percent of the ultimate design load in the diffusion bond region. Strain gages and displacement transducers were used to measure loads and deflections of the truss. The experimentally derived axial loads, bending moments, and torsion in the various members are presented and compared with predicted values.

PHYSICAL PROPERTIES

8812 Thermal conductivity of an electrically conducting epoxy below 3 K. Reynolds, C.L. Jr.; Anderson, A.C. (Department of Physics, Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Rev. Sci. Instrum.;* **48**: No. 12, 1715(Dec 1977).

Electronic conduction enhances the thermal conductivity of a commerical silver-filled epoxy below 0.5 K. When used as a bonding agent between two metals, this epoxy provides improved thermal contact; however, when one or both of the materials to be joined is a dielectric, no advantage is obtained over a pure epoxy joint due to the presence of the thermal boundary resistance.

8813 Thermal boundary resistance at metal-epoxy interfaces. Matsumoto, D.S.; Reynolds, C.L. Jr.; Anderson, A.C. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev., B;* **16**: No. 8, 3303-3307(15 Oct 1977).

Measurements of the thermal impedance across copper-epoxy-copper sandwiches have been made over a temperature range of 0.05—10 K. The data are consistent with the suggestion that only low-frequency phonons contribute to thermal transport across the sandwich. As a result the apparent thermal boundary resistance at the interfaces may be a factor of 100 larger than calculated from the theory of Little. A similar behavior should be observed whenever an amorphous material is involved.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 8510

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 7858, 8067, 8070, 8171, 8173, 8174, 8175, 8176

8814 (AD-A—041492) **Air-bonded, fod-resistant metal matrix fan blades. Final report, 20 Jun 1975—30 Jul 1976.** Doble, G.S.; Melnyk, P. (TRW, Inc., Cleveland, Ohio (USA)). Sep 1976. Contract F33615-75-C-5222. 134p. (ER—7850-2). NTIS PC A07/MF A01.

A low-cost air bonding process was developed for the fabrication of boron-aluminum fan blades from monotapes. Boron-aluminum systems of 8-mil boron—1100, 1100/2024 hybrid, and 6061 aluminum were successfully air bonded with properties equivalent to higher-cost vacuum-bonded material. The 8 mil boron-1100 system was selected for property characterization because of high Charpy energy absorption, 46 foot-lbs in +- 15 deg orientation. The mechanical properties were compared to design requirements analytically determined for an advanced first stage fan blade, the J-101.

8815 (SAND—77-1256C) **Activated gas treatment of silicone surfaces.** DeLollis, N.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 12p. (CONF-770920—3). Dep. NTIS, PC A02/MF A01.

From JOWOG-28 conference; Aldermaston, Reading, UK (20 Sep 1977).

Activated gas plasmas are very effective in increasing the surface energy of polymers to make them more wettable and bondable. Silicone rubber surfaces are successfully treated in an activated gas environment to prepare surfaces easily bonded with epoxy adhesives. Treated surfaces aged before bonding become less wettable with time and after aging up to thirty days become unbondable. Treated silicone rubber surfaces bonded within thirty minutes retain an unimpaired bond after thirty days aging at ambient or at 74°C. Weight loss studies show that silicone rubber loses negligible weight after 270 minutes exposure to either activated argon or oxygen at 50 watts power level and 0.5 torr pressure. In contrast, a polyamide cured epoxy resin may lose up to eight percent of its weight in an oxygen plasma under the same conditions of pressure and power. In argon, weight loss of the cured epoxy resin is limited to a maximum of 0.16% after 270 minutes at 50 watts.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 8068

8816 (LA—6641-MS) **P—V—T and sound velocity data for fluid n-H_2 in the range 75—307 K and 2—20 kbar.** Liebenberg, D.H.; Mills, R.L.; Bronson, J.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Jan 1977. Contract W-7405-ENG-36. 4p. E02/MF A01.

Simultaneous static measurements of pressure, volume, temperature, and sound velocity are reported in hydrogen fluid in the range 75 less than or equal to T less than or equal to 307 K and 2 less than or equal to P less than or equal to 20 kbar [0.2 to 2.0 GPa]. The 1953 sets of data points along the 60 different isotherms are presented so that they may be available for use in equation-of-state development. The equipment description, a discussion of accuracy and precision, and presentation of an equation of state are to be published in J. Chem. Phys. The data are presented on microfiche. 1 table.

8817 Critical scattering near the percolation threshold in Mn/sub c/Zn/sub 1-c/F_2. Cowley, R.A.; Shirane, G.; Birgeneau, R.J.; Svensson, E.C. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 14, 894-897(3 Oct 1977).

We report critical-neutron-scattering measurements as a function of concentration and temperature in a crystal of Mn/sub c/ Zn/sub 1-c/F_2 which has a concentration gradient such that c spans the percolation threshold c/sub p/. The results are consistent with a multicritical-point description of percolation in magnets and illustrate explicitly the importance of spin-space crossover effects on percolation. We observe no critical scattering associated with the three-dimensional phase transition for c > or = c/sub p/.

8818 Elastic neutron-scattering study of the three low-temperature transitions in tetrathiafulvalenium-tetracyanoquinodimethanide. Ellenson, W.D.; Shapiro, S.M.; Shirane, G.; Garito, A.F. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **16**: No. 7, 3244-3251(1 Oct 1977).

Elastic neutron-scattering measurements of the satellite structure of tetrathiafulvalenium-tetracyanoquinodimethanide show the existence of phase transition points at 38, 48.5, and 54 K. All of the low-temperature phases are incommensurate with a 0.295 component along b^* but differ as to their modulation along the a^* axis. These results are interpreted within the framework of a theory by Bak and Emery. An unusual hysteresis behavior in the intermediate phase between 38.5 and 48.5 K is reported. Measurements on satellites with a component of 0.59 along b^* for the lowest temperature phase are also discussed.

8819 Phonon—internal-mode hybridization in KCl:CN^-. Wood, R.F.; Mostoller, M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **39**: No. 13, 819-822(26 Sep 1977).

Recent work has shown that the resonant mixing of defect internal modes with lattice phonons can lead to striking modifications of the one-phonon coherent neutron-scattering cross section. Here, line shapes for phonons in KCl:CN^- are calculated from a two-level model and shown to agree reasonably well with experiment. Our results demonstrate that neutron scattering can be used to study the coupling of complex defects with the lattice even at low defect concentrations.

8820 Structural changes in the series $LnFeO_3$ and LnF_3. Garashina, L.S.; Vishnyakov, Y.S. (Institute of Crystallography, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 3, 313-315(May 1977).

A structural analogy is established between two classes of rare earth compounds: fluorides LnF_3 (Ln=Sm—Lu) and oxides $LnFeO_3$ (Ln=Pr—Lu). A reduction in the coordination number of the Ln^{3+} cation takes place in these compounds as a result of the displacement of the O or F atoms, leading to an increase in certain cation—anion distances. Anisotropy in the changes of individual interatomic distances is responsible for the nonmonotonic nature of the curve representing the crystal lattice parameters in the LnF_3 and $LnFeO_3$ series.

8821 Crystal structure of the compound $U_2Mn_3Si_5$. Yarmolyuk, Y.P.; Aksel'rud, L.G.; Gladyshevskii, E.I. (L'vov State University). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 3, 358-359(May 1977).

The structure of $U_2Mn_3Si_5$ is determined by x-ray diffraction analysis.(AIP)

8822 Effect of hydrostatic pressure on the phase transition in terbium molybdate. Shirokov, A.M.; Mylov, V.P.; Polkhovskaya, T.M. (Institute of Crystallography, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 3, 368(May 1977).

The influence of hydrostatic pressures up to 7 kbar on the phase transition in ferroelectric monocrystalline terbium molybdate is investigated.(AIP)

8823 Growth and certain properties of $Li_2Gd_4(MoO_4)_7$ single crystals. Bochkov, O.E.; Gorbenko, V.M.; Zabara, Y.V.; Kudzin, A.Y.; Flerova, S.A. (Dnepropetrovsk State University). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 3, 371-372(May 1977).

8824 Coexistence of two charge density waves of different symmetry in transition metal dichalcogenide 4Hb-TaS_2. Narayan, J. (Oak Ridge National Lab., TN). *Appl. Phys. Lett.;* **29**: No. 4, 223-224(15 Aug 1976).

Electron diffraction studies of 4 Hb-TaS_2 have shown that layers with octahedral (OC) and trigonal prismatic (TP) coordination undergo independent transitions to charge density wave states similar to those in 1T-TaS_2 (pure OC) and 2H-TaS_2 (pure TP), respectively. This is in agreement with the transitions observed in physical properties such as the electrical resistivity, magnetic susceptibility, and heat capacity for this material.

PROPERTIES

REFER ALSO TO CITATION(S) 7960, 8783, 8784, 8874

8825 Electrical and mechanical response of lithium niobate shock loaded above the Hugoniot elastic limit. Stanton, P.L.; Graham, R.A. (Explosives Physics Division 5131, Sandia Laboratories, Albuquerque, New Mexico 87115). *Appl. Phys. Lett.;* **31**: No. 11, 723-725(1 Dec 1977).

Z-cut lithium niobate has been subjected to shock loading over a wide stress range to determine the general character of its response. Unusual electrical and mechanical effects are observed.

8826 Studies of the luminescence efficiency of tungstate and molybdate phosphors as a function of temperature and high pressure. Tyner, C.E.; Drickamer, H.G. (School of Chemical Sciences and Materials Research Laboratory, University of Illinois at Urbana: Champaign, Urbana, Illinois 61801). *J. Chem. Phys.;* **67**: No. 9, 4103-4115(1 Nov 1977).

Studies have been made of the luminescence properties of three molybdate and three tungstate phosphors as a function of temperature and pressure. The data include peak energy, half-width, peak shape (skewness), luminescent lifetime, and integrated intensity. The modifications of the high pressure luminescence technique which permit these measurements, especially of the intensities as a function of temperature and pressure, are described. The data are analyzed in terms of a quantum mechanical single configuration coordinate model developed by Struck and Fonger. For most of the compounds studied the changes of intensity and lifetime can be reasonably correlated with the observed changes in peak energy and shape.

8827 Studies of luminescence efficiency of Eu^{2+} activated phosphors as a function of temperature and high pressure. Tyner, C.E.; Drickamer, H.G. (School of Chemical Sciences and Materials Research Laboratory, University of Illinois at Urbana: Champaign, Urbana, Illinois 61801). *J. Chem. Phys.;* **67**: No. 9, 4116-4123(1 Nov 1977).

The effect of pressure and temperature on peak energy and shape, intensity, and luminescence lifetime of a series of alkaline earth compounds doped with Eu^{2+} has been measured. The results are analyzed in terms of a quantum mechanical single configuration coordinate model. The quenching of the luminescence cannot be explained in terms of a two state model. It is possible to postulate the presence of a third state which accounts for the quenching. The properties of this third state vary in a reasonable and internally consistent manner among the compounds.

8828 Surface energy of spinel. Mishra, R.K.; Thomas, G. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Appl. Phys.;* **48**: No. 11, 4576-4580(Nov 1977).

The contributions of the Coulomb electrostatic interaction and the Born-Mayer repulsive interaction to the surface energy $MgAl_2O_4$ are calculated. These results are compared with the surface-energy values calculated from elastic constants. The results show that surfaces parallel to {111} planes are of lowest energy for $MgAl_2O_4$ spinel as well as some spinel ferrites. Except for qualitative evidence, most of these predictions await experimental verification, including the predictions of the composition of freshly cleaved spinel surfaces.

8829 Study of the LiH-Te reaction using ion backscattering. Myers, S.M. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **48**: No. 11, 4777-4782(Nov 1977).

The mechanism and kinetics of the exothermic solid-state reaction between LiH and thin-film Te have been investigated, including the effects of LiOH on the LiH surface. Single-crystal LiH was covered with ≈1 μm of vapor-deposited Te, in some cases after a layer of LiOH had formed on the LiH. The reaction 2 LiH+Te→Li_2Te +H_2up-arrow was examined by vacuum annealing in the temperature range 473—543 K with the concentration-vs-depth profiles of Te, O, and Li being determined by backscattering analysis. The results are consistent with a two-step process. First, the LiOH layer is converted to Li_2O through the thermally activated reaction LiOH+LiH→Li_2O +H_2up-arrow which produces open fissures. Second, the LiH-Te reaction occurs through these fissures with vapor transport of Te being the rate-determining step.

8830 Semiconductor surface physics research in the Space Shuttle orbit. Lindau, I.; Spicer, W.E. (Stanford University, Stanford, California 94305). *J. Vac. Sci. Technol.;* **14**: No. 6, 1285-1287(Nov 1977).

The prospects for surface physics research on semiconductors with the Space Shuttle are summarized. The effect of residual gases and solar radiation outside the Shuttle on the semiconductor-surface electronic properties are assessed.

8831 Field-dependent magnetic phase transitions in mixed-valent TmSe. Moller, H.B.; Shapiro, S.M.; Birgeneau, R.J. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 16, 1021-1025(17 Oct 1977).

A neutron diffraction study of the field-dependent magnetic ordering in TmSe is reported. The magnetic structure in zero field is antiferromagnetic fcc type I with T/sub N/ = 3.2 K. The magnetic phase diagram may be understood as a successive domain reorientation and metamagnetic transitions for T < 3 K with increasing field. We can explain this quantitatively using a simple classical spin Hamiltonian. The mixed-valent character manifests itself mainly in a reduced moment and in a markedly altered crystal field.

8832 Adsorbed oxygen as an amorphous antiferromagnetic system. Gregory, S. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **39**: No. 16, 1035-1038(17 Oct 1977).

Oxygen adsorbed on porous Vycor glass, a heterogeneous substrate, displays properties of an amorphous antiferromagnet. However, no antiferromagnetic ordering transition is seen for submonolayer coverages in the temperature range studied (1.9—95 K) although these coverages have paramagnetic Curie temperatures as large as -50 K.

8833 Multiphonon relaxation of rare-earth ions in beryllium-fluoride glass. Layne, C.B.; Weber, M.J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., B;* **16**: No. 7, 3259-3261(1 Oct 1977).

Relaxation of excited electronic states of rare-earth ions by multiphonon emission was investigated in a beryllium-fluoride glass. Decay rates were measured from the transient fluorescence following pulsed laser excitation of selected states. The multiphonon emission rates exhibit an approximately exponential dependence on the energy gap to the next-lower state and are in general agreement with the phenomenological treatment of multiphonon processes.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 8517, 8520, 8521

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 8172

8834 Injection-level dependence, frequency response, and thermal quenching of the 1.39-eV luminescence in Sn-doped LPE GaAs. Norris, C.B. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **48**: No. 11, 4706-4712(Nov 1977).

We have investigated the injection-level dependence, frequency response, and thermal-quenching characteristics of the extrinsic 1.39-eV bands in Sn-doped LPE GaAs. In lightly doped material, both the peak energy and band shape are insensitive to injection level. Frequency-response measurements show that the dynamic response of the 1.39-eV band is slow, with characteristic times of μsec. Thermal-quenching data show a relatively large activation energy which rules out the participation of normal shallow levels in the luminescence. In heavily doped material, the 1.39-eV band is very similar in shape to that in the lightly doped material. However, the band in heavily doped material shows an anomalous injection-level dependence and a lower thermal-quenching activation energy than the band in lightly doped material. Our data indicate that normal donor-acceptor pair transitions are not involved in the 1.39-eV luminescence; rather, the 1.39-eV luminescence results either from intracenter transitions in compact complexes or from partially forbidden transitions between the conduction band and a deep acceptor level associated with a complex.

8835 Electron-beam decomposition of UF_4 optical interference layers. Ellis, W.P. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Vac. Sci. Technol.;* **14**: No. 6, 1316-1317(Nov 1977).

A striking example of electron-beam damage has been observed in a LEED/Auger system with optical interference films of UF_4 on single crystalline UO_2(111). A 1-kev beam decomposed the UF_4 leaving a well-defined ring of metal which displayed detailed spatial distribution of the incident flux. Flourine was absent from the Auger spectrum and only uranium peaks characteristic of unreacted metal were obtained.

8836 Stability of lithium niobate on irradiation at elevated temperature. Primak, W.; Gavin, A.P.; Anderson, T.T.; Monahan, E. (Argonne National Lab., IL). *Nucl. Technol.;* **36**: No. 1, 79-84(Nov 1977).

In contrast to results obtained for neutron irradiation in a thermal reactor near room temperature, lithium niobate plates irradiated in the Experimental Breeder Reactor II (EBR-II) did not become metamict. This is attributed to the elevated temperature of the EBR-II. Ion bombardment experiments indicate that to avoid disordering of lithium niobate on irradiation, its temperature should be maintained above 673 K. Evidence for ionic conductivity was found at 873 K, indicating that it would be inadvisable to permit the temperature to rise that high, particularly with voltage across the plate. In reactor application as a microphone transducer, it is tentatively recommended that the lithium niobate be maintained in the middle of this temperature range for a major portion of reactor operating time.

8837 Channeling in V_3Si: Atomic displacements and electron-phonon/defect interactions. Testardi, L.R.; Poate, J.M.; Weber, W.; Augustyniak, W.M.; Barrett, J.H. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev. Lett.;* **39**: No. 11, 716-719(12 Sep 1977).

^{4}He channeling measurements of minimum yields in single-crystal V_3Si have been compared with those calculated with the Karlsruhe phonon density of states. Atomic displacements versus temperature and defect level have been so obtained. In situ radiation-damaged crystals show $\sim 10^{-1}$-A displacements and significant phonon stiffening. The observations explain the large changes in electrical resistivity in the defect state, and suggest that both thermal and static (defect) displacements diminish the electron-phonon/defect interactions, and to equivalent degrees.

8838 Radiation piezoelectric effect in germanium single crystals. Kikoin, I.K.; Kikoin, L.I.; Lazarev, S.D. *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 6, 677-678(Jun 1977).

Irradiation with ionizing particles of a germanium single crystal and uniaxial deformation at right-angles to the particle beam produced an electric field and a corresponding emf due to the radiation piezoelectric effect. Measurements were carried out when such a single crystal was irradiated with α particles and protons. The piezoelectric emf increased linearly with the compressive stress and the α-particle flux intensity. The emf depended weakly on the particle energy. The observed effect was due to the anisotropy resulting from uniaxial deformation.

8839 Annihilation of free excitons as a result of inelastic scattering by silane molecules in silicon. Safronov, L.N.; Obodnikov, V.I. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 6, 681-684(Jun 1977).

An investigation was made of the low-temperature photoluminescence of silicon irradiated with 400—500 keV H^+_2 ions at an elevated temperature. The 0.9 eV band dominating the photoluminescence spectra was demonstrated to be due to the annihilation of free excitons and excitation of local vibrations of silanes formed as a result of the H^+_2 irradiation in the temperature range 300< or =T/sub irr/< or =500°C. The changes in the luminescence spectrum (broadening and shift of the main band toward higher energies and the appearance of another band) observed on cooling were attributed to the low-temperature formation of large silane molecules whose size was governed by their stability at a given irradiation

temperature. The silane molecules were found to occupy interstitial positions in the silicon lattice.

8840 Formation of a surface peak of structure defects formed by ion irradiation. Abroyan, I.A.; Titov, A.I.; Khlebalkin, A.V. (M. I. Kalinin Polytechnic Institute, Leningrad). *Sov. Phys. - Semicond. (Engl. Transl.);* **11**: No. 6, 712-713(Jun 1977).

Silicon was bombarded with 50 keV nitrogen ions. The degree of disorder was determined by the secondary-emission method. A surface peak in the distribution of structure defects with depth was found to be due to diffusion of defects to the surface.

8841 Reversal of polarization in triglycine sulfate crystals and the dependence of this process on defects already existing in the crystals. Komlyakova, N.S.; Likhov, A.B.; Malek, Z.; Rudyak, V.M.; Shuvalov, L.A. (Kalinin State University, Institute of Crystallography, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 3, 323-326(May 1977).

Slow polarization-reversal processes taking place in triglycine sulfate crystals in sharply changing fields are studied, together with the influence of defects arising during the growth of the crystals and after irradiating them with small doses of soft x radiation on these processes. There are two mechanisms of polarization reversal. On increasing the degree of defectiveness the switching time increases monotonically, while the amount of charge switched diminishes. The contribution of abrupt processes of polarization reversal also declines. Radiation annealing of the defects does not take place.

8842 Effectiveness of the action of various forms of radiation on quartz. Semenov, K.P.; Fotchenkov, A.A. *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 3, 326-330(May 1977).

The magnitude and depth distribution of the absorbed dose and Frenkel defect concentration in quartz irradiated by electrons and protons of various energies, U^{235} fission neutrons, and Co^{60} gamma quanta are calculated. On the basis of improved models of defect centers, an explanation is given for the behavior of synthetic quartz in the process of irradiation and annealing. Conclusions are drawn as to the character of the interaction between various forms of radiation and quartz at various stages of irradiation.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 7850, 7851

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 8081

8843 (PB—267283) **Nondestructive multielement instrumental neutron activation analysis.** Moore, R.V.; Propheter, O.W. (Environmental Protection Agency, Athens, Ga. (USA). Environmental Research Lab.). Feb 1977. 25p. (EPA—600/4-77/011). NTIS PC A02/MF A01.

A nondestructive instrumental neutron activation analysis procedure permitted accurate and sensitive measurement of most elements with atomic numbers between 11 and 92. The sensitivity of the procedure was dependent on each element's intrinsic characteristics and the sample matrix. Arsenic was used both as an elemental single comparator and as a thermal neutron flux monitor. Comparison conditions were established for both long and short irradiations. Other elemental standards, or unknown samples, were irradiated with flux monitors. Gamma counts of the sample were compared with those of the standards, both having been adjusted to the standard conditions through the flux monitors. The procedure permitted wide latitude in irradiation time, decay time, multichannel analysis time, relative detector-to-sample geometry, and sample size. Analysis of standard reference materials showed that 16 out of 23 elements in Orchard Leaves, for which comparison data were available, agreed within 20%. In Coal 24 out of 30 elemental analyses, and in Coal Fly Ash 21 out of 29 elemental analyses, agreed within 20% of comparison data. Differences greater than 50% were found for antimony, zinc, and a few trace elements near their detection limits.

8844 (PB—267508) **Elemental analysis of human lung tissue and other selected samples utilizing neutron activation analysis.** Filby, R.H. (Washington State Univ., Pullman (USA). Nuclear Radiation Center). May 1975. Contract PHS-HSM-99-71-27. 30p. NTIS PC A03/MF A01.

A total of 31 samples are analyzed by neutron activation analysis for magnesium, manganese, chromium, iron, cobalt, zinc, selenium, bromine, antimony, arsenic, tantalum, tellurium, mercury, nickel, copper, molybdenum, cadmium, silver, bismuth, iodine, uranium, gold, iridium, rubidium, sodium, potassium, cesium, chlorine, lanthanum, and scandium. Samples analyzed include coal miners' lungs, non-miners' lungs, coal dust, coal filters, rat lungs, tumorous and non-tumorous tissue, animal diets and asbestos minerals. Neutron activation analysis is found suitable for the measurement of trace elements in lung tissue samples. As many as 22 elements may be determined non-destructively. Acid decomposition techniques for lung tissue should be replaced by fusion technique to ensure complete decomposition of the sample.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 7861, 8024, 8068

8845 (PB—268240) **Determination of hydrogen sulfide in refinery fuel gases. Final report.** Knoll, J.E.; Midgett, M.R. (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Environmental Monitoring and Support Lab.). Jan 1977. 40p. (EPA—600/4-77/007). NTIS PC A03/MF A01.

Several widely employed test methods for the iodimetric measurement of hydrogen sulfide in refinery fuel gases are shown to suffer from serious thiol interferences. An absorbing solution consisting of 0.16 M cadmium sulfate/sulfuric acid at pH 3.0 is shown to be effective for the collection of hydrogen sulfide in the 70-700 mg/m^3 range and to be essentially free from interference by up to 1800 mg/m^3 of methanethiol. When combined with a single 3 percent hydrogen peroxide impinger, sulfur dioxide interferences of up to 1,300 mg/m^3 are also removed. No measureable interference results from the presence of carbon oxysulfide, ethene, dimethyl sulfoxide, or thiophene. Acetaldehyde and acetone are observed to interfere at the 2,400 and 48,000 mg/m^3 level, respectively. It is proposed that the absorption solution described here be substituted for the cadmium hydroxide/cadmium sulfate mixture used in the EPA test method (Method 11) for determining the hydrogen sulfide content of refinery fuel gases.

8846 Cause of loss of hydrogen-overvoltage on graphite electrodes used for anodic stripping voltammetry. Clem, R.G. (Univ of Calif, Lawrence Berkeley Lab). *Anal. Chem.;* **47**: No. 11, 1778-1784(Sep 1975).

Work with neutron-damaged graphites shows conclusively that structure is not the cause of anodic stripping voltammetry (ASV) electrode failure. Mercuric and especially trace silver-ion strongly catalyze the oxidation of the graphite electrode surface with the result that graphite oxides are formed. Formation of carboxyl groups are the likely cause of loss of hydrogen overvoltage. Electrode behavior after treatment with vacuum ultraviolet light, diazomethane, lithium aluminum hydride, dimethylmercury, various amines, and propylene oxide is described. 26 refs.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 7871, 9013

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 8025

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 7855, 7982, 9075

8847 (ORNL—5171, pp 133-141) **Chemical physics.** Compton, R.N.; Carter, A.; Cooper, C.D. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The reaction $Cs + SF_4 \rightarrow Cs^+ f\ SF_4^-$ was studied. The ion yields of UF_6^-, F^-, and another ion (103 +- 3 amu) were determined vs T in the reaction of hot U with F gas. Electron affinities for some heavy elements (Cu, Ag, Au, Pt) were calculated using Slater's transition-state method. Reactions between crossed beams of alkali atoms and UF_6 were studied; the electron affinity of UF_5 is calculated to be 4 +- 0.3 eV. Multiphoton ionization of the Cs atom is under study using tunable dye lasers. Rotational resonances (dipole states) in electron—polar molecule systems is also under study. A potential-energy function for diatomic molecules was discovered for which the Schroedinger equation can be solved exactly. (DLC)

8848 Temperature dependence of the total reaction rates for Cl+HI and Cl+HBr. Mei, C.; Moore, C.B. (Department of Chemistry, University of California). *J. Chem. Phys.;* **67**: No. 9, 3936-3939(1 Nov 1977).

Thermal reaction rate constants have been determined for the reactions Cl+HI and Cl+HBr in the temperature range 220—400 °K. The rates vary slowly with temperature. For Cl+HI the effective reaction cross section reaches a maximum of 31 A^2 near 300 °K. A tentative reaction model is proposed in which the attacking halogen atom is attracted to the halogen end of the hydrogen halide and then rotation of the hydrogen, with little or no activation energy, completes the reaction.

8849 Thermodynamics of electrolytes. 8. High-temperature properties, including enthalpy and heat capacity, with application to sodium chloride. Silvester, L.F.; Pitzer, K.S. (Univ. of California, Berkeley). *J. Phys. Chem.;* **81**: No. 19, 1822-1828(22 Sep 1977).

The ion-interaction type of equation which has proven so successful for activity and osmotic coefficents of both pure and mixed electrolytes near room temperature is extended for wide temperature ranges and for the enthalpy and heat capacity. An improved equation is obtained for the dielectric constant of water over a wide range of temperature and density; it is used to calculate the Debye-Hueckel parameters to 350°C for enthalpy and heat capacity as well as for osmotic and activity coefficients. These equations are applied to the extensive array of thermodynamic data for aqueous sodium chloride from 0 to 300°C. Good agreement is obtained and the equations thus provide a convenient analytical representation of the thermodynamic properties of NaCl(aq). Also the results indicate that at 300°C sodium chloride is still a strong electrolyte with little tendency toward the formation of ion pairs.

ORGANIC CHEMISTRY

REFER ALSO TO CITATION(S) 7831

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 7855, 7867

8850 Domain structure and time-dependent properties of a crosslinked urethane elastomer. Lagasse, R.R. (Sandia Labs., Albuquerque, NM). *J. Appl. Polym. Sci.;* **21**: No. 9, 2489-2503(Sep 1977).

The morphology of a chemically crosslinked urethane elastomer is correlated with its time-dependent mechanical properties. Evaluation of this amorphous elastomer by electron microscopy and small-angle x-ray scattering reveals that incompatible chain segments cluster into separate microphases having a periodicity in electron density of about 90 A. This observed domain structure is similar to that seen previously in uncrosslinked, thermoplastic urethane elastomers. As in earlier studies on such linear systems, thermal pretreatment of the crosslinked elastomer causes a time-dependent change in its room temperature modulus. However, the magnitude of this modulus change (about 20%) is generally less than observed previously with the linear systems. Another contrast with previous findings is that this time-dependent phenomenon is apparently not caused by thermally activated changes in microphase segregation. Rather, the observed time dependence in modulus is believed to be caused by molecular relaxation resulting in densification of amorphous packing within the hard-segment domains. The validity of this proposed mechanism is supported by differential scanning calorimetry experiments showing evidence of enthalpy relaxation during room-temperature aging of the elastomer. This relaxation is qualitatively similar to that observed previously during sub-T/sub g/ annealing of single-phase glassy polymers.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 7860

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 8849

PHOTOCHEMISTRY

8851 In situ photolysis-electron spin resonance study of some reactions of phosphate radicals. Maruthamuthu, P.; Taniguchi, H. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **81**: No. 20, 1944-1948(6 Oct 1977).

Free radical intermediates formed in the reaction of phosphate radicals (PO_4^{2-} or its protonated forms, HPO_4^- and H_2PO_4) with a number of fundamental organic and inorganic compounds have been studied by the in situ photolysis-steady state ESR method. The phosphate radicals were generated effectively by the photolysis of peroxodiphosphate ($P_2O_8^{4-}$) in aqueous solutions. Though the phosphate radical itself could not be detected directly, the ESR spectra of the phosphate radical adducts to fumaric and maleic acids and also the aci-anion of nitromethane were observed successfully. The pK/sub a/ value for the proton dissociation in the phosphate group of the adduct to fumaric and maleic acids, $^-OOCCH(OPO_3H^-)CHCOO^-$, has been determined to be 6.7. The reactions of phosphate radicals are rather similar to those of the related active species SO_4^-, e.g., they give rise to hydroxyalkyl radicals from aliphatic alcohols, adduct radicals with unsaturated compounds, and inorganic radicals such as CO_3 from HCO_3 and PO_3^{2-} from HPO_3^{2-}. However, there are notable differences in reactions with aliphatic and aromatic carboxylic acids. From saturated aliphatic mono- and dicarboxylic acids, α-carbon radicals produced by hydrogen abstraction with phosphate radicals were predominantly detected in neutral aqueous solutions and phenyl-type radicals were not detected from aromatic carboxylic acids. On the contrary the resultant radicals by decarboxylation were mainly observed in SO_4^- system. Clearly, direct oxidative electron transfer is not the predominant process in the reaction of the phosphate radical (HPO_4^-) with carboxylic acids.

8852 Temperature dependence of the recombination fluorescence of photoionized indole and N,N,N',N'-tetramethyl-p-phenylenediamine in organic glasses. Consequences of electron tunneling and diffusion. Ho, K.K.; Kevan, L. (Wayne State Univ., Detroit). *J. Phys. Chem.;* **81**: No. 19, 1865-1871(22 Sep 1977).

The recombination fluorescence seen when TMPD is photoionized in methylcyclohexane, 3-methylhexane, and 2-methyltetrahydrofuran glasses and when indole is photoionized in 2-propanol and ethanol glasses has been investigated. The initial intensity and decay rate of the recombination fluorescence decreases as the UV irradiation temperature is increased from temperatures below the glass transition temperature T/sub g/ of the matrix. This is interpreted in terms of electron tunneling to the cation in which the tunneling barrier height or electron trap depth increases slightly (0.05 to 0.2 eV) with increasing irradiation temperature. By considering how the matrix polarity affects the degree of electron trap deepening as well as the electron trap depth relative to the excited singlet level of the solute, we are able to understand the difference in magnitudes and their changes for the initial decay rate and the initial recombination fluorescence. At temperatures 10 to 30 K above T/sub g/, depending on the matrix polarity, diffusive recombination dominates tunneling recombination and produces a peak in the recombination fluorescence unless the electron trap depth has dropped below the excited singlet of the solute. Thus, this type of experiment offers a simple diagnostic for distinguishing tunneling and diffusive recombination of electrons with cations in disordered matrices.

RADIATION CHEMISTRY

8853 Comment on "Probability of escaping neutralization when the mobility is field dependent". Baird, J.K.; Anderson, V.E.; Rice, S.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **67**: No. 8, 3842-3844(15 Oct 1977).

The field dependence of the electron mobility in dielectric liquids is discussed.(AIP)

8854 Kinetic study of the formation of excited States in the pulse radiolysis of gaseous xenon—iodine systems. Cooper, R. (Univ. of Melbourne, Parkville, Australia); Grieser, R.; Sauer, M.C. Jr. *J. Phys. Chem.;* **81**: No. 20, 1889-1894(6 Oct 1977).

Light emission in the ultraviolet region is observed from gaseous mixtures of xenon and iodine using the pulse radiolysis technique with subnanosecond time resolution. Emission maxima at about 253 and 319 nm are ascribed to XeI*($^2\Sigma$/sub ½), and kinetic evidence is presented which supports the conclusion that XeI* is formed by reaction of ground state Xe with excited molecular iodine. Evidence is also presented which indicates that the same species is formed by a sequence of ionic reactions. An emission band due to excited I_2, with a maximum at 342 nm, is also observed. Three distinct reaction sequences, one of which involves ions, are involved in producing the excited I_2.

8855 Micellar catalysis of radical reactions. A spin trapping study. Bakalik, D.P.; Thomas, J.K. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **81**: No. 20, 1905-1908(6 Oct 1977).

The reaction of surfactant radicals and the spin trap 2-methyl-2-nitrosopropane has been investigated. Sodium dodecyl sulfate and sodium octyl sulfate show no spin adduct when surfactant and spin trap are irradiated with ^{60}Co at concentrations below their critical micelle concentration (CMC). At concentrations above the cmc a nitroxide is formed from the reaction of the trap and a secondary surfactant radical produced via hydroxyl radical attack on the hydrocarbon chain. The micellar catalytic effect and the site of hydroxyl radical attack are discussed.

8856 **Polyelectrolyte effects on rates of hydrated electrons.** Jonah, C.D.; Matheson, M.S.; Meisel, D. (Argonne National Lab., IL). *J. Phys. Chem.;* **81**: No. 19, 1805-1810(22 Sep 1977).

The effect of polyvinylsulfate (PVS) on the rate of the reaction of e^-/sub aq/ with several species highly reactive toward e^-/sub aq/ was investigated using the pulse-radiolysis technique. The rate of e^-/sub aq/ reactions with cations (Cu^{2+}, Cd^{2+}, Ni^{2+}, Zn^{2+}, $Ru(bpy)_3^{2+}$, $Fe(phen)_3^{2+}$, Cr^{3+}, Eu^{3+}) is greatly inhibited by the presence of the polyelectrolyte. On the other hand, the reaction wth negatively or uncharged species (NO^-_3 and O_2) is hardly affected. It is shown that using this kinetic method the effective number of available sites on te polymer can be titrated. Furthermore, the specificity constants of cations, inert toward e^-/sub aq/ (Mg^{2+}, Ca^{2+}, Ba^{2+}, Li^+, Na^+, K^+), could be determined by measuring their effect on the rate of the reaction of e^-/sub aq/ with a probe cation (Cu^{2+}) "condensed" on the polymer. As expected from measurements of thermodynamic properties of similar polyelectrolytes, and from theoretical models, it was found tha divalent ions are bound to the polymer much stronger than are univalent ions. For ions of similar valence the specificity constant is larger, the smaller is the hydrated ionic radius.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 8847

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 7879

ENGINEERING

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 7946

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 8440

8857 (N—77-22422) **An investigation of electrohydrodynamic heat pipes. Final report.** Loehrke, R.I. (Colorado State Univ., Fort Collins (USA). Dept. of Mechanical Engineering). Mar 1977. Contract NGR-06-002-127. 51p. (NASA-CR—151977). NTIS PC A04/MF A01.

The principles of electrohydrodynamic heat pipe operation are discussed, and evaporator conductance experiments are described. A heat pipe was designed in which grooved and ungrooved evaporator surfaces could be interchanged to evaluate the necessity of capillary grooves. Optimum electrode spacing was also studied. Finally, heat convection in evaporating thin films is considered.

8858 (NP—22471) **Improving the efficiency of axial turbines by reducing the secondary losses.** Pruemper, H. (Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Maschinenwesen). 15 Nov 1975. 263p. (In German). Dep. NTIS (US Sales Only), PC A12/MF A01.

Secondary losses occurring in turbine guide vanes, especially near the walls, can be reduced to a high degree by installing boundary layer fences or boundary layer grooves of appropriate dimensions, design, and arrangement on the profiled suction sides. The most important geometrical parameter is the depth of the grooves, i.e., the height of the fences projecting into the flow channel. Higher mean efficiencies were usually obtained with boundary layer grooves in the guide vane. Also, this arrangement turned out to be very indifferent to large changes in the Mach number. The efficiency of boundary layer fences in the rotor was demonstrated by measurements with circulating probes. Two fences on the profiled suction sides are necessary, and the wall distance must be greater than that in the guide vane. These results are of great importance for turbines with short blades and especially for the advancement of small gas turbines.

8859 (ORNL/Sub—4484/3) **Estimates of costs of conventional coal fired steam production plants.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Jun 1977. Contract W-7405-ENG-26. 71p. (UEC-UCC—770617). Dep. NTIS, PC A04/MF A01.

The costs of steam supply plants using stoker and pulverized coal firing was estimated. Conceptual designs have been prepared for each combustion system for plants with one and four 250,000 pound per hour boilers producing steam at 650 psig and 750 F. The capital costs of these plants are very dependent on the site, application, and type of coal selected. Capital costs of about $50 to $55 per pound per hour of capacity can be expected for single unit plants. Four unit plants cost less, approximately $35 to $45 per pound per hour, because of the many systems which are common to all boilers. Operations and maintenance costs, excluding coal, were also prepared. These also can vary widely, depending on the specific plant application. For this estimate, it was assumed that the steam plant would be staffed independently of adjacent process facilities.

8860 (ORNL/SUB—4484/4) **Estimate of costs of a stoker fired hot water generator plant.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Jul 1977. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

The cost of a hot water generator plant utilizing stoker firing was estimated. A conceptual design was prepared for a plant producing 250,000 pounds per hour of 350°F saturated water. This is equivalent to a plant output of 25,000,000 BTU/hour. As designed, the plant is moderately sophisticated, and is designed for low operating and maintenance costs. Requirements of a specific user, site, and application could increase or decrease capital costs significantly. Operating and maintenance costs were estimated, based on a semi-independently operating plant. These also are very dependent on the specific site and operation. A summary of the capital and operating and maintenance costs is presented.

8861 (TAC-HP—76-001) **Heat pipe technology. Quarterly update, March 31, 1976.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). 1976. vp. of New Mexico, Albuquerque.

Heat Pipe Technology is a continuing bibliographic summary of research on heat pipes. The first volume was published in the spring of 1971 and is cumulative through March of that year. The 1971, 1972, 1973 and 1974 Annual Supplements have been published and distributed. This update to Heat Pipe Technology cites the additional references identified during January, February and March of 1976. It is intended to provide "current awareness" to heat pipe researchers.

8862 (TAC-HP—76-003) **Heat pipe technology. Quarterly update, September 30, 1976.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). 1976. vp. of New Mexico, Albuquerque.

Heat Pipe Technology is a continuing bibliographic summary of research on heat pipes. The first volume was published in the spring of 1971 and is cumulative through March of that year. The 1971, 1972, 1973 and 1974 Annual Supplements as well as the 1975 Quarterly Update Series have been published and distributed. This update to Heat Pipe Technology cites the additional references identified during July, August, and September of 1976. It is intended to provide "current awareness" to heat pipe researchers.

8863 (TAC-HP—76-004) **Heat pipe technology. Quarterly update, December 31, 1976.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). 1976. vp. of New Mexico, Albuquerque.

Heat Pipe Technology is a continuing bibliographic summary of research on heat pipes. The first volume was published in the spring of 1971 and is cumulative through March of that year. The 1971, 1972, 1973 and 1974 Annual Supplements as well as the 1975 Quarterly Update Series have been published and distributed. This update to Heat Pipe Technology cites the additional references identified during October, November and December of 1976. It is intended to provide "current awareness" to heat pipe researchers.

8864 (TAC-HP—77-002) **Heat pipe technology. Quarterly update, April—June 1977.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Aug 1977. 35p. of New Mexico, Albuquerque.

Heat Pipe Technology is a continuing bibliographic summary of research on heat pipes. The first volume was published in the spring of 1971 and is cumulative through March of that year. The 1971, 1972, 1973 and 1974 Annual Supplements as well as the 1975 and 1976 Quarterly Update Series have been published and distributed. This update to Heat Pipe Technology cites the additional references identified during April, May and June of 1977. It is intended to provide "current awareness" to heat pipe researchers.

8865 **Microcomputer-based controller for temperature programming the direct inlet probe of a high-resolution mass spectrometer.** Pomernacki, C.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Rev. Sci. Instrum.;* **48**: No. 11, 1420-1427(Nov 1977).

A microcomputer-based temperature controller has been developed which uses the high-level language basIc. The controller dynamically programs the temperature profile of the direct-inlet probe in a high-resolution mass spectrometer. Temperature sensing is accomplished using a probe-mounted thermocouple which feeds a digital thermometer. A microprocessor, executing a digital propor-

tional-plus-integral-plus-derivative (PID) feedback-control algorithm in interpretive basIc, reads the probe temperature once every second and computes a control action. This action determines a power-level setting for the probe heater, thus completing the feedback path. The controller has been used for linear-ramp pyrolysis experiments on the mass spectrometer. Performance curves for the ramp response, as well as for step responses, are exhibited. A steady-state precision of +- 0.1°C is attained. The microcomputer approach is open-ended in that more complex temperature profiles and control algorithms are achievable by changing the software program. The generality of implementation is sufficient enough to allow its application to other pyrolysis experiments.

8866 New arrangement for high-intensity 313-nm light. Ahmed, F.E.; Robb, D.C.; Hart, R.W. (Department of Biophysics, The Ohio State University, Columbus, Ohio 43210). *Rev. Sci. Instrum.;* **48**: No. 11, 1442-1444(Nov 1977).

We describe a new arrangement high-intensity 313-nm light for studies on photolysis of bromodeoxyuridine-substituted DNA. This device was mainly made of aluminum, except for lamp mounts which were of stainless steel. Water, used for cooling and ventilation depending on convection currents, was essential for optimal operating conditions of the lamps. Two high-pressure mercury quartz lamps and two bandpass filters were used for selective passage of 313-nm light. Physical calibration was achieved by using a gas photodiode. Calibration filter sets reduced the intensity of the 313-nm light below the photodiode saturation level. Manufacturers, suppliers, and specifications are given in the text. This device has the advantages of being comparatively inexpensive, easily constructed and used, and producing 313-nm light of high intensity.

8867 Irradiation installation for ionizing radiation. Meyer, R. (to Siemens AG). US Patent 4,047,043. 6 Sep 1977. Priority date 12 Jun 1975, German, Federal Republic of (F.R. Germany). 6p.

The invention relates to an irradiation or exposure installation for ionizing radiation, with at least one radiation detector exposed to the radiation, including a radiation monitor for the presetting of the radiation dosage which is to be currently applied and for the limitation of the latter to the presently preset reference value, including a preadjustable integrating unit which is connected to the radiation monitor, and with an automatic shut-off device actuatable through intermediary of the integrating unit upon reaching of the preset radiation dosage.

8868 Analytical investigation of maximum heat transfer capacity of heat pipes. Semena, M.G.; Gershuni, A.N.; Rassamakin, B.M. (Kiev Polytech Inst, Ukr SSR). *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 5, 93-97(May 1977). (In Russian).

An anlytical solution is obtained determining the hydrodynamic boundary of the heat transfer capacity of a cylindrical heat pipe with an annular isotropic wick. The differential equation of motion of a liquid in the heat pipe wick is solved by the method of separation of variables (the Fourier method) using an orthonormalized basis in order to improve the convergence of the series. A program for computer-aided solution of particular problems is developed. Results of calculations by the proposed method are compared with experimental data obtained for water heat pipes with metal fiber wicks. Calculated valves of maximum heat fluxes are in satisfactory agreement with experimental data.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 8313, 8965, 8966, 9382, 9448, 9449, 9454, 9455, 9456, 9457, 9458, 9461

8869 (N—77-22424) **Joule-Thomson expander and heat exchanger. Final technical report.** Norman, R.H. (AiResearch Mfg. Co., Torrance, Calif. (USA)). 17 Nov 1976. Contract NAS2-8984. 67p. (NASA-CR—151978). NTIS PC A04/MF A01.

The Joule-Thomson Expander and Heat Exchanger Program was initiated to develop an assembly (JTX) which consists of an inlet filter, counterflow heat exchanger, Joule-Thomson expansion device, and a low pressure jacket. The program objective was to develop a JTX which, when coupled to an open cycle supercritical helium refrigerating system (storage vessel), would supply superfluid helium (He II) at 2 K or less for cooling infrared detectors.

8870 New technique for improved low-temperature SQUID NMR measurements. Webb, R.A. (Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **48**: No. 12, 1585-1594(Dec 1977).

A description of the technique used for performing a variety of SQUID NMR measurements in fields varying from 3.7 to 309 G is presented. Pulsed NMR, cw NMR, adiabatic fast passage, and static susceptibility measurements have been made on liquid ^{3}He, using the same detection system, in the temperature range 1.2K—2mK. The spin-lattice relaxation times varied from 100 s at 1 K to as fast as 0.26 ms at 2 mK. The spin—spin relaxation times varied from 3×10^{-5} s in 309 G to nearly 3×10^{-3} s in 3.7 G.

8871 Bakeable, ultrahigh-vacuum compatible, retractable contacting mechanism for in situ thin film resistance and superconductivity measurements. Miller, D.L. (Brookhaven National Laboratory, Upton, New York 11973). *Rev. Sci. Instrum.;* **48**: No. 12, 1717-1718(Dec 1977).

A bakeable, ultrahigh-vacuum compatible, retractable four-point resistance probe has been constructed to make in situ measurements of superconductivity in ultrathin films. A bellows actuation mechanism allows the very compact contacting mechanism to be withdrawn from the substrate area for cleaning and characterization of the substrate surface, then returned for film resistance measurements. The device has been used to make contact to Pb films less than 10 A thick deposited on high-resistivity Si substrates, which require a cleaning step that would be destructive to permanent or predeposited contacts.

8872 Transients in superconducting turbogenerators with freely rotating outer screen. Allinger, G. (Tech Univ, Muenchen, Ger). *Arch. Elektrotech. (Berlin);* **59**: No. 4, 221-228(Jul 1977).

Fault transients in ac machines cause grid-frequency torque pulsations. For 2-pole superconducting turbogenerators in the range of rating limit a mechanical resonance frequency close to the grid frequency is expected if a screen is fixed to the inner rotor. So it must be reckoned that inadmissibly high mechanical stresses occur in the rotor construction. Therefore, in this paper the operational consequences of using a free rotating outer screen are studied. For a simplified mathematical model of the turbogenerator the nonlinear differential equations describing the behavior are derived. In the rotating parts a random number of screens is permitted. The results of a numerical integration are presented for a three-phase short circuit with subsequent voltage recovery and for a faulty synchronization.

8873 Detection of microwave radiation with an S-N point junction. Bevza, Y.G.; Karamushko, V.I.; Dmitrenko, I.M. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR, Khar'kov). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 387-389(Mar 1977).

A new type of detection process operates in the microwave irradiation of an S-N (superconductor-normal metal) point junction in the absence of a constant transport current. The magnitude and polarity of the rectified voltage are governed by the magnitude and sign of an external magnetic field. It is also found that the detection properties of an N-N point contact (an MOM diode) change when one of the metals of the junction pair becomes superconducting.

8874 Materials of cryogenic structure. Lehuen, C. (Alsthom-Atl, Belfort, Fr). *Rev. Gen. Electr.;* **86**: No. 1, 45-50(Jan 1977). (In French).

The difficulty in defining selection criteria for cryogenic materials are pointed out. The different mechanical and physical characteristics of these materials and the materials available, either metallic or non-metallic, as well as their properties are described. In conclusion, the stress is laid on the importance of studies and development tests both in the case of new materials and of new operating conditions.

8875 Structure of a cryogenerator stator, winding and environment protection. Heuillard, J.F. (DEM, Alsthom-Atl, Fr). *Rev. Gen. Electr.;* **86**: No. 1, 51-56(Jan 1977). (In French).

Compared with a conventional turbogenerator set, the increase of voluminal power is obtained both by the use of a superconducting field magnet and by the increase of the linear load of the armature. The solution using a flux attraction arragement, with laminated crown which forms a natural crown which forms a natural anchoring structure, offers the best dimensioning gain. The stator winding fitted in the air-gap necessitates a complete radial and tangential transposition of the basic wires. For an output of 3,000 MW, the hot winding is more advisable than the cold solution (77°C) both concerning losses and the dielectric. Since the winding of a cryogenerator is submitted to stresses 2 to 3 times higher than those of a conventional machine, new fitting processes will have to be devised.

8876 Few aspects of the development of a 500 kw cryogenic generator. Faure-Brac, G.; Ferrari, M.; Pinet, C.; Ranard, M. (CNRS, Fr). *Rev. Gen. Electr.;* **86**: No. 1, 69-72(Jan 1977). (In French).

The different phases of development of a 500 kW generator with hypersynchronous torque transmission are described, viz.: construction of the superconducting field magnet, development and testing of a prototype cryostat and its rotating joint. Finally, the overheating of the solid metallic parts of the field magnet in transient conditions is considered. Advantages of a hypersynchronous torque transmission are pointed out.

8877 Superconducting low-speed synchronous motors. Pouillange, J.P. (CERCEM, Fr). *Rev. Gen. Electr.;* **86**: No. 1, 73-76(Jan 1977). (In French).

The paper summarizes the main results of a prospective study tending to the application of superconductors to ship propulsion. The plant considered consists of two loops, each provided with a turbine, a superconducting generator, a frequency converter through which the generator feeds a low-speed synchronous motor fitted with a superconducting field magnet, while the armature may be either classic or superconducting.

8878 Design and construction of a superconducting synchronous machine. Ushio, K.; Kaiho, K.; Nomura, H. *Denki Shikensho Iho;* **41**: No. 2-3, 192-204(1977). (In Japanese with English abstract).

A 10 kVA prototype generator has been designed and constructed in order to investigate the features of superconducting synchronous machines which are applicable to very large machines. The experimental machine is a vertical shaft type and has an inner rotating field winding and fixed armature winding which are made of NbTi superconductors. Discussed are the distribtuion of magnetic field produced by the superconducting field winding, relations between the thickness of stiffening plate and bending flexure due to the electromagnetic force, structure of armature and field windings, characteristics of cryostat and rotating shaft, etc. Results of calculation of the inductance in each winding and the proposed rating of the completed generator are shown. Further, equations are introduced to give a no-load voltage of the armature, which is proportional to the field current and the number of revolutions because no iron core is used.

8879 On the design of armature winding of large superconducting synchronous machine. Ushio, K. *Denki Shikensho Iho;* **41**: No. 2-3, 236-241(1977). (In Japanese with English abstract).

Armature winding problems for a large superconducting synchronous generator are studied. The higher flux density produced by the superconducting field winding, increase in the space for the armature conductors owing to the absence of iron, and reduction of insulation requirements allow better utilization of space and materials. To reduce the eddy current loss and ohmic loss in the armature winding, the conductor has an optimum size. Round strand conductors, with individual wires each having a diameter of approximately 1 mm, are adopted. Plastics (epoxy/glass, etc.) are widely used as structural materials, but problems of their elastic hysteresis are not yet solved. The key or wedge system is considered to be suitable for structural bracing of the armature winding. The current density rating is determined not only by the heating loss, but also by the value of reactance in some cases. Some methods of winding are proposed to generate higher terminal voltages so that the first transformer is dispensed with.

8880 Investigation of cryogenic cycles with wet vapor expansion machines. Ardashev, V.I.; Mikulin, E.I.; Plachendovskii, D.I.; Zholsharev, A. (Moscow Higher Tech Sch N.E. Bauman, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 87-92(1977). (In Russian).

Cycles of cryogenic air, hydrogen, and helium liquefying installations with wet vapor expansion machines instead of a throttle at the lower stage of cooling are analyzed. They are compared with similar cycles that include a throttle, other conditions being equal. The comparison concerns energy consumption per unit of the cryogenic product and the conventional specific heat transferring surface of liquefier heat exchangers.

8881 Origination of the normal zone in a superconducting cable with partial cryostatic stabilization. Blinkov, Y.L.; Kuno, M.Y.; Smirnov, S.K.; Bendik, N.T.; Goldenberg, Y.S. (G.M. Krzhizhanovsky Power Eng Inst, Moscow, USSR). *IEEE Trans. Magn.;* **MAG-11**: No. 2, 389-392(Mar 1975).

This paper deals with the origination and variation in length of the normal zone in a superconducting cable. A convenient approximate formula for the propagation velocity of a semi-infinite zone was obtaoned by assuming a linear decrease of critical current with increasing temperature. The peculiarities of the normal zone's growth were studied in a cable with an initial gradient of gas temperature. The process of expansion and contraction of a normal zone of finite length is described. Data are given on the experimental study of the movement of a normal zone in the three-phase superconducting cable model.

8882 Magnetization currents in windings of superconducting dipole and quadrupole magnets and their effect on field accuracy. Asner, A. (CERN, Geneva, Switz). *Bull. Schweiz. Elektrotech. Ver.;* **66**: No. 8, 434-437(1975). (In German).

When superconducting magnetic windings are excited, magnetization currents with critical current density J/sub c/ flow in the superconductor, in each filament. The two oppositely flowing currents form elementary dipoles in each filament and distort the original field distribution. The field distortion for concentric dipole and quadrupole magnets with sectorial windings is calculated and the effect of excitation current, field of winding, critical current density, and superconductor dimensions is presented.

HANDLING EQUIPMENT AND PROCEDURES

8883 Fission and explosive energy releases of PuO_2, PuO_2—UO_2, UO_2, and UO_3 assemblies. Koelling, J.J.; Hansen, G.E.; Byers, C.C. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **35**: No. 3, 611-616(Oct 1977).

The critical masses and fission and explosive energy releases of PuO_2, PuO_2—UO_2, UO_2, and UO_3 assemblies have been calculated. The parameters selected for the model are conservative. They were chosen after review of appropriate plants that have been and are proposed for construction in the future. The resulting data envelopes are intended to include any conceivable set of circumstances that could ultimately lead to a nuclear incident. All energy release analysis was performed for initial fission spikes only: recriticality mechanisms were not considered.

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 9504

8884 (ORNL/ENG/TM—5) **Safety analysis report for packaging: the ORNL gas-cylinder fire and impact shield.** Evans, J.H.; Levine, D.L.; Eversole, R.E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 129p. Dep. NTIS, PC A07/MF A01.

The ORNL radioactive gas-cylinder fire and impact shield was designed and fabricated at the Oak Ridge Gaseous Diffusion Plant for the transport of cylinders filled with radioactive gases. The shield was evaluated analytically and experimentally to determine its compliance with the applicable regulations governing containers in which radioactive and fissile materials are transported. Computational and test procedures were used to determine the structural integrity and thermal behavior of the cask relative to the general standards for normal conditions of transport and the standards for hypothetical accident conditions. Results of the evaluation demonstrate that the container is in compliance with the applicable regulations.

TRANSPORT AND STORAGE FACILITIES

8885 Methods for conveying and weighing:designing for batch and continuous weighers. Mitchell, J.R. *Chem. Eng. (N.Y.);* **84**: No. 5, 176-183(Feb 1977).

The accuracy of weighing equipment for powders and granular materials, bunker design, and power requirements are discussed.

8886 Electrostatic charge generation during tank washing. spark mechanisms in tanks filled with charged mist. van de Weerd, J.M. (K/Shell Lab, Amsterdam, Neth). *J. Electrost.;* **1**: No. 3, 295-309(Aug 1975).

Under conditions of tank washing several possible sparking mechanisms were investigated involving conducting objects not bonded to the tank. Some of the tests were done in a full-scale 12,000 m^3 shore tank containing an electrostatically charged mist generated by a tank washing machine. Sparking mechanisms were identified associated with the formation of unbonded conductors in the form of water masses ("water slugs") by the water jets used for tank cleaning. Ignition experiments were performed using masses of water as unbonded conductors. They produced sparks of sufficient intensity to ignite hydrocarbon--air mixtures under conditions relevant to the practical situation in tankers.

8887 Electrostatic charge generation during tank washing. reducing hazardous space potentials in tankers: a theoretical and experimental approach. Lindbauer, R.L. (K/Shell Lab, Amsterdam, Neth). *J. Electrost.;* **1**: No. 3, 273-294(Aug 1975).

The hazard arising from the washing of tanks with powerful jets of water is discussed and defined in terms of space potential. Methods are presented for the reduction of these space potentials created by electrostatically charged water mist. Special consideration is given to "passive" systems, whose effectiveness and reliability or reduction stem more or less from their mere presence in the tank. Theoretical work and model studies leading up to successful experiments with dividing wires in a 12,000 m^3 tank are presented.

8888 Biggest merchant ship ever built in the western hemisphere. *Mar. Eng./Log;* **80**: No. 6, 27-31, 95(Jun 1975).

The 265 000 tdw VLCC Massachusetts has a length oa of 335.28 m, a beam of 54.25 m, a draft (summer) of 20.45 M and is powered by a G.E. cross compounded turbine unit having an ABS continuous rating of 35,000 shp at 85 rpm giving a speed of 15 1/4 knots. Cargo capacity is 2,055,432 bbl.

8889 Dutch Master chemical tanker for Broere, Dordrecht. *Holland Shipbuild.;* **24**: No. 4, 28-30(Jun 1975).

The 2 320 tdw chemical tanker "Dutch Master" has a length oa of 80.30 m, a beam of 12.00 m, a draft of 5.425 m and is powered by a RBY-6-M-358 Deutz diesel engine developing 2 000 bhp at 280 rpm giving a service speed of 13.5 knots. The vessel has 12 stainless steel cargo tanks with a total capacity of 2 290 m^3.

8890 **Static electrification in supertankers.** Makin, B. (Univ of Dundee, Scotl). *Phys. Technol.;* **6**: No. 3, 109-116(May 1975).

Static electricity can lead to a devastating explosion in today's mammoth supertankers. The article examines the causes of static in supertankers, charge generation in flowing liquids and looks at methods of static prevention.

8891 **Shell semi-submersible tanker loading unit design appraised by Lloyd's register.** *North. Offshore;* **4**: No. 5, 38, 41(May 1975).

The Tanker Loading Unit (TLU) is designed for operation as a manned crude loading single point mooring buoy in the open sea. Its basic designs is that of a column stabilizer semi-submersible unit. The basic dimensions and arrangement of the three main parts are such that the TLU may be constructed in a shipyard with each section being erected on top of the other (in the telescoped configuration) ready for launching and transit. The working superstructure consists of the accomodation deck, diving deck and machinery deck. On location the TLU receives processed crude oil for loading into tankers from an adjacent production storage platform through a submarine pipeline terminating in a manifold on the seabed under the TLU.

8892 **Monitoring the speed performance of ships.** Townsin, R.L.; Moss, B.; Wynne, J.B.; Whyte, I.M. *North East Coast Inst. Eng. Shipbuild., Trans.;* **91**: No. 5, 159-178(May 1975).

A generalized system for speed performance monitoring is described in detail from collecting the data to presenting the analysis to management. A less satisfactory system based on fuel consumption is outlined for those ships without torsionmeters. The estimation of voluntary and involuntary speed loss of large tankers in heavy weather is discussed as an example of results from a monitoring system: a simple formula is given for involuntary speed loss in head weather. Fouling and roughness are well known causes of speed loss and these are considered in the light of recent research in Newcastle University. Two appendices give a description of the power diagram and results from the calculation of optimum docking intervals.

8893 **Boelwerf-built, multi purpose product carrier 'Maaskade'.** *Holland Shipbuild.;* **24**: No. 2, 36-41(Apr 1975).

The 31 707 tdw product carrier "Maaskade" has a length oa of 170.690 m, a beam of 26.028 m, a draft (summer) of 11.413 m, and is powered by a seven cylinder B and W type 7K74EF diesel engine rated at 13 500 bhp giving a service speed of 15.5 knots. The vessel has been designed for the carriage of mineral oil products but a number of chemicals may also be transported.

8894 **Research on electrostatic hazards associated with tank washing in very large crude carriers (supertankers)--1. introduction and experiment modelling.** Bright, A.W.; Hughes, J.F.; Makin, B. (Univ of Southampton, Engl). *J. Electrost.;* **1**: No. 1, 37-46(Feb 1975).

To supplement the full scale trials, designed to investigate the reasons behind the explosions which occurred during tank cleaning of three supertankers, a parallel research program was started using small scale equipment. The area of concern was the incendivity of electrical discharges in a charged water aerosol and the basic processes in the charge generation mechanism when a water jet disintegrates. The justification of the scaling is based on comparison with full scale data and by maintaining a constancy of the more important parameters in the real and model tests.

8895 **Research on electrostatic hazards associated with tank washing in very large crude carriers (supertankers)--2. study of the charging mechanism during the production of water aerosols.** Bassett, J.D. (Univ of Southampton, Engl). *J. Electrost.;* **1**: No. 1, 47-60(Feb 1975).

Some initial results are described of an investigation into the charging mechanisms which operate when water droplets in the size range observed during tank cleaning are produced. A brief review of relevant previous work is given, followed by a discussion of the mechanisms which might be important. An experimental system designed to investigate the mechanisms is described, and experimental results for the droplets produced from carbon dioxide and sodium nitrate solutions are given and discussed. The atomization process was also briefly investigated and preliminary high speed cine observations are discussed.

8896 **Practical and computer assessments of ignition hazards during tank washing and during wave action in part-ballasted OBO cargo tanks.** Chubb, J.N. (UK At Energy Auth Res Group, Abingdon, Oxfs, Engl). *J. Electrost.;* **1**: No. 1, 61-70(Feb 1975).

The theoretical, experimental and practical studies which were carried out at Culham Laboratory up to March 1973 on the mechanisms by which electrostatic hazards arise in the operation of large oil tankers are described. Theoretical calculations show that hazardous sparks (with energy above 0.2 mJ) can be expected when fairly modest sized slugs of water, perhaps as small as 100 mm long, 20 mm dia, arrive at a projection such as a washing machine in a tank filled with a typical charged mist. Hazards can also be expected during sloshing in part-ballasted tanks. Experimental studies show that the incendivity of electrostatic sparks is affected by the velocity of approach of the discharge surfaces. Radio techniques have been developed for monitoring the occurrence of electrostatic sparks. 11 refs.

8897 **Unit trains--a tool for improved service and profit.** Martin, J.R. (South Railw Syst, Atlanta, Ga). *Am. Soc. Mech. Eng., [Pap.];* No. 75-ICT-1, 1-4(1975).

A general overview of unit train operation is given, including a review of benefits to railroad, shipper, and receiver. The transport of coal is considered in detail, but other commodities suited to unit train movement are suggested as well. The conclusion is that unit train operation can reduce costs and improve service for high volume movements of bulk commodities.

8898 **Experience with a long distance unit coal train.** Angold, J.A. (Atchison Topeka and Santa Fe Railw Co, Chicago, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 75-ICT-4, 7(1975).

The paper provides an insight into the operation and maintenance experiences encountered during 7 1/2 years of operation of a unit coal train, that makes a 2164-mile round trip over a territory of varied operating and climatic conditions every 96 hr.

MINING AND DRILLING EQUIPMENT AND FACILITIES

8899 (COO—4037-3) **Downhole drilling motors: technical review. Final report.** Maurer, W.C.; McDonald, W.J.; Nixon, J.D.; Matson, L.W. (Maurer Engineering, Inc., Houston, Tex. (USA)). 1 Aug 1977. Contract EY-76-C-02-4037. 180p. Dep. NTIS, PC A09/MF A01.

Dyna-Drills and turbodrills are used primarily for directional drilling where it is critical that the drillpipe not be rotated. These tools are not widely used for straight-hole drilling because of problems with bearing failures, low power outputs, low bit pressures, and high rotary speeds. The high rotary speeds produce bit bearing failures in 10 to 15 h, compared to 100 to 200 h life at lower rotary speeds. The technology now exists to develop reliable high-torque motors which will operate roller bits at speeds of 150 to 250 RPM and diamond bits at speeds of 400 to 800 RPM for periods of 100 to 200 hours. Sealed bearing assemblies which allow the bearings to operate in lubricant are being developed. These improved bearings allow bits to operate at the high bit weights needed for optimum drilling. Improved drilling motors can reduce drilling costs to significantly increase the number of wells drilled per drilling rig per year. Now, this is increasingly important because of the drilling rig shortage developing in this country. At least ten companies are working on the development of improved drilling motors and it is likely that several of these new motors will become commercially available within the next 2 to 3 years. Several companies are working on the development of improved high speed roller bits for use on drilling motors. The development of these high speed bits should significantly increase the use of drilling motors since bit bearing failures are a major problem when drilling with motors. The development of reliable, high-speed STRATAPAX bits should also increase motor useage since these bits drilling most effectively at rotary speeds of 300 to 500 RPM.

LASERS

REFER ALSO TO CITATION(S) 9175

8900 (AD-A—040596) **Theoretical studies of high-power ultraviolet and infrared materials. Technical report no. 8, 1 July—31 December 1976.** Sparks, M.; Duthler, C.J. (Xonics, Inc., Santa Monica, Calif. (USA)). 31 Dec 1976. Contract DAHC15-73-C-0127. 337p. NTIS PC A15/MF A01.

The main thrust of the program in the current report period has been on analyzing the expected performance of high-power reflectors and windows for use in the wavelength region from 250 to 350nm, in anticipating potential problems for these reflectors and windows, and in seeking solutions. Several exciting new results were obtained. The abstracts and summaries in the Introduction and Summary subsections of the individual sections provide an outline of the central results. The following list is intended to provide an overview and a very brief summary of the results obtained to date. (1) Theoretical results for the failure modes of reflectors and windows are derived and applied to a model system with wavelengths lambda = 250 to 350nm, pulse duration t(p) = 1 microsecs, repetition rate 100 Hz (to 1000 Hz), reflector absorptance .005, extrinsic window material absorptance .0001 (absorption coefficient beta =

.0001/cm for a one-centimeter-thick window), and lambda/40 allowed optical phase distortion. (Author)

8901 (AD-A—041215) **New materials for chemical laser windows. Final report, Jun—Dec 1976.** Harrington, J.A.; Gregory, D.A.; Rosenstock, H.B.; Hass, M. (Alabama Univ., Huntsville (USA)). Feb 1977. Contract N00014-76-C-0941. 55p. (UAH-RR—198). NTIS PC A04/MF A01.

Many of the more common materials such as the alkaline earth fluorides, ZnSe, and the alkali halides have been studied for use as low loss windows on DF-HF chemical lasers; yet, there remain others which have received little or no attention at these wavelengths. Some of these other materials were studied in hopes of finding additional low absorbing materials which show potential as laser windows.

8902 (COO—4080-3) **Development of improved laser glasses which can be melted on a commercial scale. Second quarterly progress report, January 1, 1977—March 31, 1977.** Rapp, C.F.; Vergano, P.J. (Owens-Illinois, Inc., Toledo, Ohio (USA)). 1977. Contract EY-76-C-02-4080. 32p. Dep. NTIS, PC A02/MF A01.

The progress made during the second three-month period of the program to develop low n_2 fluorophosphate laser glasses is reported. This report covers the time period from January 1, 1977 to March 31, 1977. The most significant progress made during this time was: (1) the completion of construction of the fluoride melting furnace; (2) the identification of the alkaline earth fluoride-AlF_3-$Al(PO_3)_3$ system as being that which shows the most promise for producing glasses which meet the program objectives; and (3) the production of several glasses which meet or nearly meet the program's objectives.

8903 (N—77-22464) **Diode pumped Nd:YAG laser development. Final report.** Reno, C.W.; Herzog, D.G. (RCA Advanced Technology Labs., Camden, N.J. (USA)). May 1976. Contract NAS5-23281. 99p. (NASA-CR—152492; ATL-CR—76-02). NTIS PC A05/MF A01.

A low power Nd:YAG laser was constructed which employs GaAs injection lasers as a pump source. Power outputs of 125 mW TEM CW with the rod at 250 K and the pump at 180 K were achieved for 45 W input power to the pump source. Operation of the laser, with array and laser at a common heat sink temperature of 250 K, was inhibited by difficulties in constructing long-life GaAs LOC laser arrays. Tests verified pumping with output power of 20 to 30 mW with rod and pump at 250 K. Although life tests with single LOC GaAs diodes were somewhat encouraging (with single diodes operating as long as 9000 hours without degradation), failures of single diodes in arrays continue to occur, and 50 percent power is lost in a few hundred hours at 1 percent duty factor. Because of the large recent advances in the state of the art of CW room temperature AlGaAs diodes, their demonstrated lifetimes of greater than 5,000 hours, and their inherent advantages for this task, it is recommended that these sources be used for further CW YAG injection laser pumping work.

8904 (N—77-22466) **Development of far infrared attenuation to measure electron densities in cw pin discharge lasers. Final report.** Babcock, R.V. (Westinghouse Research Labs., Pittsburgh, Pa. (USA)). 1977. Contract NAS3-19702. 46p. (NASA-CR—135154). NTIS PC A03/MF A01.

A two beam attenuation technique was devised to measure electron densities of 10^9 to 10^{11} cm/3 resolved to 1 cm, in a near atmospheric COFFEE laser discharge, using 496 micrometer and 1,220 micrometer radiations from CH_3F, optically pumped by a CO_2 laser. A far infrared generator was developed which was suitable except for a periodic intensity variation in FIR output deriving from frequency variation of the pump radiation.

8905 (N—77-22468) **Proposed computer model for electric discharge atomic vapor lasers.** Harstad, K.G. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 15 Mar 1977. Contract NAS7-100. 90p. (NASA-CR—152681). NTIS PC A05/MF A01.

A detailed computer model for the rate kinetics of an atomic vapor laser excited by electrical discharge is proposed. The model equations are defined and the computer program structure is discussed.

8906 (N—77-24468) **Stabilization of He_2(a-3 sigma u(+)) molecules in liquid helium by optical pumping for vacuum uv laser.** Zmuidzinas, J.S. (National Aeronautics and Space Administration, Pasadena, Calif. (USA)). 29 Mar 1977. Contract NAS7-100. 13p. NTIS PC A02/MF A01.

A technique is disclosed for achieving large populations of metastable spin-aligned He_2 molecules in superfluid helium to obtain lasing in the vacuum ultraviolet wavelength regime around 0.0800 micrometers by electronically exciting liquid (superfluid) helium with a comparatively low-current electron beam and spin aligning the metastable molecules by means of optical pumping with a modestly-powered circularly-polarized CW (continuous wave) laser. Once a high concentration of spin-aligned He_2 is achieved with lifetimes of a few milliseconds, a strong microwave signal destroys the spin alignment and induces a quick collisional transition of He_2 molecules to a lasing transition.

8907 **Nonlinear refractive index of fluoride crystals.** Milam, D.; Weber, M.J.; Glass, A.J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Appl. Phys. Lett.;* **31**: No. 12, 822-825(15 Dec 1977).

Nonlinear refractive-index coefficients of 11 fluoride crystals were measured at 1064 nm using time-resolved interferometry. A simple empirical expression is given for the index nonlinearity in terms of the d-line refractive index and Abbe number which agrees with measured values for both fluoride crystals and optical glasses and which can be used to estimate index nonlinearities. Since the nonlinear indices of several fluoride crystals are among the smallest reported for solids, these materials are of interest for transmitting optical components in high-power laser systems where self-focusing is important.

8908 **Cw and improved pulsed operation of the 14- and 16-μm CO_2 lasers.** Wexler, B.L.; Manuccia, T.J.; Waynant, R.W. (Laser Physics Branch, Optical Sciences Division, Naval Research Laboratory, Washington, D.C. 20375). *Appl. Phys. Lett.;* **31**: No. 11, 730-732(1 Dec 1977).

The performance of the 14- and 16-μm CO_2 lasers produced in the electric discharge gasdynamic laser has been significantly improved by the addition of a small percentage of H_2 to deactivate the (01^10) level. This addition tripled the pulsed output of the laser, and 45 μJ at 14 μm and 25 μJ at 16 μm were observed. cw oscillation was achieved for the first time, with output powers of 0.6 and 0.9 W, respectively. The effect of collisional processes in limiting the CO_2 density is discussed.

8909 **Double-pulse laser flashlamp pumping and a new method of flashlamp triggering.** Mroczkowski, J.A.; Milburn, R.H. (Department of Physics, Tufts University, Medford, Massachusetts 02155). *Rev. Sci. Instrum.;* **48**: No. 12, 1555-1559(Dec 1977).

The design of a flashlamp triggering and driving circuit is described for the short pulse pumping of a Nd^{3+} YAlO crystal suitable for Q-switched operation. The special features of this system were a prepulse circuit for pulsing the flashlamp immediately before the main pulse, and a new method of flashlamp triggering based upon a saturable choke. An increase in laser efficiency and pulse reproducibility was obtained when the prepulse mode of operation was used.

8910 **Aluminum-coated Pyrex double-ellipse laser cavity.** Chu, S.; Commins, E. (University of California, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Appl. Opt.;* **16**: No. 10, 2619-2620(Oct 1977).

The construction and advantages of a Pyrex flashlamp cavity are discussed.(AIP)

8911 **Laser beam divergence utilizing a lateral shearing interferometer.** Riley, M.E.; Gusinow, M.A. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Appl. Opt.;* **16**: No. 10, 2753-2756(Oct 1977).

An analysis of the lateral shearing interferometer is given for laser beams. The results enable a simple determination of the local radius of curvature of the wavefront. In addition, the presence of phase distortion in the beam may be ascertained.

8912 **Double heterostructure lasers having reduced microstress.** Kirkby, P.A. (to International Standard Electric Corp.). US Patent 4,047,123. 6 Sep 1977. Priority date 26 Sep 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A conventional construction of light emissive III-V semiconductor device is modified by the inclusion in the active region of the device of not more than 5 at. percent of a group III or group V substituent of significantly different atomic radius than that of the element for which it is substituted. The microstress field in the neighborhood of dislocation in the active region produces local modification of the concentration of the substituent causing a reduction in the magnitude of the microstress field associated with these dislocations.

8913 **Mode-locked-laser for very-wide-band communication systems.** Zenchenko, S.A.; Livshits, M.G.; Shevchik, T.I. (Scientific-Research Institute for Applied Physics Problems at the V. I. Lenin Belorussian State University, Minsk). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 679-681(Jun 1977).

The results are given of an investigation of mode locking in an He—Ne laser used in a fast-response communication system. A determination is reported of the frequency width of the mode-locking band in which optical pulses of stable amplitude and phase, suitable for communication purposes, are generated. It is shown that the unavoidable variations of the laser parameters have a strong influence on the optimal intracavity modulation frequency and the

necessary (for mode locking) magnitude of dissipative perturbations. The results are given of a study of the phase characteristics of an optical pulse generator based on a mode-locked He—Ne laser. It is shown that stabilized self-mode-locking can be used to improve the phase stability of the output light pulses.

8914 Competition between stimulated Raman scattering and parametric oscillation in the resonator of an optical parametric oscillator with an $LiIO_3$ crystal. Dzhotyan, G.P.; D'yakov, Y.E.; Pershin, S.M.; Kholodnykh, A.I. (M. V. Lomonosov State University, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 692-697(Jun 1977).

A report is given of the observation of stimulated Raman scattering inside the resonator of an optical parametric oscillator with an $LiIO_3$ nonlinear element. It is shown that, under certain conditions, the pump energy can be converted efficiently into the Stokes component of the signal wave in the oscillator. The principal relationships governing the efficiency of this process are found in the quasistatic approximation. An analysis of a simultaneous system of approximate transient equations describing parametric oscillation and stimulated Raman scattering shows that "spiky" emission is possible. The investigated system is a new and promising modification of a Raman laser with a double optical resonator and a tunable excitation source.

8915 Influence of a longitudinal magnetic field on nonreciprocal effects in a ring laser. Andronova, I.A.; Kuvatova, E.A. (Scientific-Research Radiophysics Institute, Gorki). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 697-701(Jun 1977).

A theoretical analysis is made of the nonreciprocal effects which occur in a ring laser when its active medium is subjected to a longitudinal magnetic field (the analysis is carried out ignoring saturation in the active medium). The difference between the frequencies of the opposite waves and the values of the excess over the threshold for these waves are shown to be related to the difference between the polarizations due to inaccuracies in the manufacture and alignment of the resonator elements. The nonreciprocal effects are considered for the case of one and two modes. A physical interpretation of the results obtained is given.

8916 Recombination lasers utilizing vapors of chemical elements. I. Principles of achieving stimulated emission under recombination conditions. Zhukov, V.V.; Latush, E.L.; Mikhalevskii, V.S.; Sem, M.F. (State University, Rostov-on-Don). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 708-714(Jun 1977).

A general analysis is made of the characteristics of laser action resulting from plasma recombination in the afterglow of a gas discharge. It is shown that efficient pumping of the active levels by impact-radiative recombination can be achieved by establishing a fairly high plasma density, cooling as fast and as much as possible the electron gas after a current pulse, and utilizing the recombination of doubly charged ions with a high initial concentration. It is shown that the most convenient approach is the utilization of the recombination in the afterglow of a discharge in a vapor of an easily ionizable element mixed with helium. The requirements to be satisfied by the distribution of the active levels are formulated in the approximation of level groups bearing in mind that the transitions due to electron deexcitation are very important during the plasma relaxation period. A generalized criterion is obtained for the existence of a population inversion. The cases of radiative and collisional regimes are discussed separately for the case of widely spaced levels. The paper concludes with a formulation of the general requirements to be satisfied by the distribution of levels so that an inversion is obtained under recombination-collisional kinetics conditions.

8917 Phase transitions in formation of spatially coherent laser beams. Pakhalov, V.B.; Chirkin, A.S. (M. V. Lomonosov State University, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 715-719(Jun 1977).

The results are reported of an investigation of the changes in the spatial coherence (correlation) radius r/sub c/ and radiation intensity I on approach to the laser threshold. It is shown that their behavior obeys the laws r/sub c/proportional (δ-δ/sub th/)/sup -alpha/and Iproportional (δ-δ/sub th/)/sup -beta/where δ/sub th/ is the threshold value of the losses at which stimulated emission begins; α and β are the critical exponents. It is reported that measurements carried out on an He—Ne laser give $\alpha = 0.49 \pm 0.05$ and $\beta = 0.9 \pm 0.2$. These values of α and β are in agreement with the theory of formation of spatially coherent beams in lasers based on the wave approach ($\alpha = 0.5$, $\beta = 1.0$). The agreement of the experimental results with the Landau theory of phase transitions of the second kind is discussed.

8918 Influence of the main factors on the efficiency of coherent emission as a result of reaction of hydrogen with fluorine. Igoshin, V.I.; Nikitin, V.Y.; Oraevskii, A.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 723-729(Jun 1977).

A fairly simple kinetic model is proposed for th H_2+F_2 laser in which allowance is made for the principal features of the physicochemical kinetics. This model is used to calculate the dependences of the efficiency and duration of emission of coherent radiation from a laser amplifier on the degree of initiation, initial chemical composition of the mixture, duration of the initiation pulse, concentration of the photoinitiating component, rate of initiation (for constant initiation pulse duration), pressure in the mixture, and oxygen concentration. The kinetics of a laser oscillator is also considered.

8919 Subnanosecond periodically Q-switched neodynium glass laser. Bykovskii, N.E.; Pletnev, N.V.; Senatskii, Y.V. (P. N. Lebedev Physics, Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 732-734(Jun 1977).

A train of pulses of $\sim 5 \times 10^{-10}$ sec duration and $\sim 2 \times 10^{-3}$ J energy was generated by a periodically Q-switched neodymium glass laser. The width of the emission spectrum was ~3.0 nm and the contrast of the emitted radiation exceeded 10^3. Pulse generation started after 10—20 passes through the resonator. The pulses could be synchronized with external apparatus to within $\sim 10^{-9}$ sec. Stable generation of pulse trains was observed when the pumping rate exceeded considerably the threshold value. A laser of this kind could be used as a source of short pulses which could then be amplified effectively in high-power neodymium-glass systems.

8920 Investigation of a plasma mirror of an electron-beam-controlled CO_2 laser with heating radiation power densities of 10^{11}—10^{12} W/cm². Boiko, V.A.; Danilychev, V.A.; Zvorykin, V.D.; Ivanova, T.G.; Kholin, I.V.; Chugunov, A.Y. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 735-738(Jun 1977).

It is shown that when an electron-beam-controlled CO_2 laser operates in a simple single-stage scheme with a plasma mirror, the laser radiation is absorbed efficiently in the plasma. For a heating radiation power of several tens of gigawatts and a power density at the target $q \sim 10^{11}$—10^{12} W/cm², the electron temperature and density in the plasma mirror were T/sub e/ ~200 eV and N/sub e/ $\sim 10^{19}$ cm^{-3}. Helium-like Mg XI ions were obtained.

8921 Shaping of the output beam in a pulsed gas laser with an unstable resonator. Isaev, A.A.; Kazaryan, M.A.; Petrash, G.G.; Rautian, S.G.; Shalagin, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 745-752(Jun 1977).

An examination is made of the transient process of output beam shaping in high-gain pulsed lasers with a short inversion lifetime. It is shown that to obtain an output beam with diffraction-limited divergence in such lasers, resonators with large magnifications M must be used. Results are reported of experiments on pulsed copper vapor lasers. Studies were made at different levels of excitation of the active medium over a wide range of variation of M.

8922 Investigation of optical inhomogeneities in chemical lasers. Zykov, L.I.; Kirillov, G.A.; Kormer, S.B.; Nikolaev, V.D.; Sukharev, S.A. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 752-754(Jun 1977).

An experimental study was made of the changes in the refractive index Δn of the active media of F_2+D_2+He (CO_2, SF_6) chemical lasers during stimulated emission. It was established that 80—90% of the energy was emitted by a laser when the active medium was optically homogeneous (vertical-barΔnvertical-bar < or $= 2 \times 10^{-7}$). The change in the refractive index at the end of a stimulated emission pulse did not exceed $(0.7—1.5) \times 10^{-6}$. This change was attributed to gasdynamic motion of the medium because of its nonuniform heating by the chemical reaction.

8923 Stability of single-mode emission from a laser. Likhanskii, V.V.; Napartovich, A.P. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 763-765(Jun 1977).

It is shown that single-mode emission may be unstable in the absence of spatial and spectral "hole burning" if the distribution of the losses in the resonator is inhomogenous. An expression is obtained for the instability growth increment on the assumption that the single-pass gain is small when allowance is made for the gain dispersion. It is demonstrated that, in general, there are two pump power thresholds, i.e., single-mode emission is unstable, when the pumping rate lies in a certain range that depends on the parameters of the resonator and the medium it contains.

8924 Possibility of amplification of light in a recombining thallium fluoride plasma. Gudzenko, L.I.; Marchenko, V.S.; Yakovlenko, S.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 6, 775-776(Jun 1977).

A discussion is given of the processes during the decay of a $TlF+F_2$ plasma which impair the amplification of light by transitions of thallium atoms to the ground state.

8925 Some characteristics of stimulated emission from thin-film lasers with adjoining amplifying media. Avdeeva, N.I.; Borisov, V.I.; Lebedev, V.I. (Institute of Physics, Academy of Sciences of the Belorussian SSR, Mogilev). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 6, 776-778(Jun 1977).

A comparative study was made of the characteristics of stimulated emission from thin-film lasers in the form of an amplifying waveguide layer or in the form of a waveguide with an adjoining amplifying medium (WAAM). The advantage of the WAAM laser was the technological separation of the fabrication of waveguide and amplifying layers. The amplifying media were liquid and polymer films activated with rhodamine 6G. It was found that, in contrast to lasers with active waveguide layers, the WAAM lasers emitted mainly high-order transverse modes. The threshold optical pump powers for both types of laser could be similar.

8926 Unstable resonator with field rotation. Zavgorodneva, S.I.; Kuprenyuk, V.I.; Sherstobitov, V.E. *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 6, 787-788(Jun 1977).

An analysis is made of the possibility of using the rotation of the field in unstable resonators to reduce their sensitivity to intracavity distortions. It is shown experimentally that a considerable improvement in the angular characteristics of laser radiation with cylindrical-lens distortions can be achieved by the use of an unstable resonator with field rotation.

8927 Stimulated emission of three lines from an N_2+Ar laser. Bychkov, Y.I.; Losev, V.F.; Mesyats, G.A.; Tarasenko, V.F. (Institute of Atmospheric Optics, Siberian Branch, Academy of Sciences of the USSR, Tomsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 6, 789-790(Jun 1977).

Stimulated emission was observed from an N_2+Ar laser at three wavelengths ($\lambda=337.1$, 357.7, and 380.5 nm) of the 2^+ nitrogen system. The time, energy, and spectral characteristics of the radiation were determined.

8928 Frequency tuning of PbTe injection lasers by combined action of pressure and temperature. Anzin, V.B.; Britov, A.D.; Glushkov, M.V.; Itskevich, E.S.; Kalyuzhnaya, G.A.; Kosichkin, Y.V.; Shirokov, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 6, 793-797(Jun 1977).

The radiation emitted from a PbTe injection laser was tuned in the wavelength range 5—9.6 μ using an independent optical high-pressure chamber and a cryostat with a consinuously flowing cooling agent. The wide-range (within 600 cm^{-1}) pressure tuning was combined with continuous temperature tuning (within 400 cm^{-1}). The pressure was varied from 0 to 12 kbar and the temperature from 4 to 120°K. The system was used in a laser spectrometer.

8929 New rapidly relaxing passive shutter for a neodymium-glass laser. Babenko, V.A.; Kudinova, M.A.; Malyshev, V.I.; Prokhorov, A.M.; Sychev, A.A.; Tolmachev, A.I.; Shchelev, M.Y. (P. N. Lebedev Physics Institute, USSR Academy of Sciences, Institute of Organic Chemistry, Ukrainian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 341-344(20 Apr 1977).

We report the development of a passive shutter whose bleached time has a record low value tau=1.5 psec. This shutter has been produced for the first time and ensures stable generation of light pulses of 2 psec duration. Results are reported of investigations of the generation characteristics of a laser with the new passive shutter.

8930 Laser-pumped tunable dye laser. Karpushko, F.V.; Sinitsyn, G.V. (Institute of Physics, Academy of Scineces of the Belorussian SSR, Minsk). *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 4, 137(Apr 1977).

Frequency selection for a dye laser is demonstrated by the use of a thin-film interferometer with an intermediate ZaS film.(AIP)

8931 Inert gases as a component of the medium of a reactor laser. Gudzenko, L.I.; Lakoba, I.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 4, 222-223(Apr 1977).

Calculations are performed on the energy-level transitions that are to be expected in a reactor laser using XeF as the active medium. (AIP)

8932 Gain on transitions of hydrogenic ions in an expanding plasma. Luk'yanov, G.A. (Leningrad Mechanics Institute). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 361-364(Mar 1977).

The possibility of using an expanding plasma of hydrogenic ions for gain is studied. The conditions under which population inversion occurs are determined. Plasma properties, which optimize gain are determined. It is shown that there are important restrictions on the use of ions with a charge greater than three. Approximate equations are derived for the maximum population inversion, the gain, and the specific radiation power. As the charge of the ions increases, these properties increase rapidly. The analysis is carried out for optically thick and thin plasmas.

8933 Weak-signal gain in a CO gasdynamic laser. Belavin, V.A.; Abrosimov, G.V.; Andronov, G.A.; Armer, A.G.; Dymshits, B.M.; Koretskii, Y.P.; Sharkov, V.K. (Scientific-Research Institute of Nuclear Physics, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 364-365(Mar 1977).

A calibrated-loss method is used to measure the weak-signal gain in a 38:62 CO:Ar mixture expanding in a conical supersonic nozzle. The nozzle is 56 cm long and has an expansion ratio of 1600. At a stagnation pressure of 83 +- 4 atm and a stagnation temperature of 2130 +- 100^0K the measured gain reaches a value of 2.7—3.2%/cm for the various vibrational-rotational transitions of the CO molecule.

8934 Contribution to the theory of photon spectra in a semiconductor laser. Elesin, V.F.; Kopaev, Y.V. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 177-179(Jan 1977).

The spectrum of the supercondensate photons in a semiconductor laser is obtained at a large excess above threshold. The supercondensate photons are the result of an interaction between the condensate photons (via the electron system). This phenomenon is analogous to the "pushing out" of particles from a non-ideal Bose condensate. In contrast to the case of an equilibrium non-ideal Bose gas, however, the number of supercondensate photons increases with time. The instability of the photon condensate in the laser is due to the fact that the processes of production of supercondensate photons from the condensate are real.

8935 Large volume TEA co_2 amplifier. Domey, J. (Gen-Tec Inc, Ste-Foy, Que). *Rev. Sci. Instrum.;* **46**: No. 7, 811-813(Jul 1975).

A 15X15 cm cross section, 50 cm long, TEA CO_2 amplifier using a reliable and simple discharge system is described. This system permits external control of the width of the discharge and is easily scalable. The spatial distribution of the small signal gain over the cross section of the amplifier is investigated. An average small signal gain coefficient of 0.022 cm^{-1} is obtained at an input energy density of 100 J/liter. Measurement of the saturated energy gain is reported. The small signal gain has also been measured on a smaller cross section but more heavily excited amplifier, using a similar discharge system.

8936 Calculation of some characteristics of a cw carbon dioxide laser with a non-self-maintained discharge. Babaev, I.K.; Blinov, N.A.; Dolgov-Savel'ev, G.G.; Orlov, V.K.; Savel'ev, V.V. *Sov. J. Quant. Electron. (Engl. Transl.);* **4**: No. 12, 1483-1484(Jun 1975).

A simple method is given for the analytic calculation of the energy distribution function of electrons in arbitrary mixtures of CO_2, N_2 He, Xe, and other gases. The influence of easily ionizable admixtures and of an external ionization source on the distribution function is discussed. An analytic calculation is made of the distribution of the parameters of a gas stream, laser level populations, and gain for a gas-discharge channel in which the initial velocity is less than 100 m/sec. It is shown that an increase in the pressure of a mixture accompanied by a proportional increase in the pump power should result in lowering of the value of the gain and in narrowing of the gain band along the stream. 4 refs.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 7803, 7913, 8015, 8324, 8336, 8511, 8540, 8861, 8862, 8863, 8864

8937 (CONF-761039—) **Two-phase flow and heat transfer symposium-workshop. Proceedings of condensed papers.** Veziroglu, T.N. (ed.). (National Science Foundation, Washington, D.C. (USA); Miami Univ., Coral Gables, Fla. (USA). Clean Energy Research Inst.). 1976. 327p. Publishing Corp., Washington, DC $35.00.

From Two-phase flow and heat transfer symposium; Fort Lauderdale, Florida, United States of America (USA) (18 Oct 1976).

Two-phase flow applications are found in a wide range of engineering systems, such as boiling water reactors, conventional steam boilers, evaporators of refrigeration systems, and evaporative and condensive heat exchangers in chemical and petroleum industries. Over the past two decades, two-phase flow instability problems have been a challenge to many investigators. Such instabilities could induce boiling crisis, disturb control systems and/or cause mechanical damage. It is important to be able to predict the conditions under which a two-phase flow system will perform without instability. Therefore, the understanding of two-phase flow phenomena is extremely important for the design, control and performance prediction of such systems. Because of the recent energy crisis, many other two-phase flow problems have also become important. Some of them are the modeling of the loss of coolant accident in pressurized water nuclear reactors, scaling up of fluidized bed reactors for

converting coal to clean gaseous and liquid fuels, and design of heat exchangers for liquified natural gas, and design of heat exchangers for liquified natural gas. There is a need to provide researchers and engineers in this field with an opportunity to exchange their experience and ideas in order to assess the state-of-the-art of two-phase flow and heat transfer studies, and to establish a basis for identification of areas of future research and application. This symposium provides the latest information on the status of two-phase flow and heat transfer research, development and applications. It also establish a rational basis for identification of areas of two-phase flow and heat transfer for further research and application.

8938 (COO—4155-3) **Nonlinear Rayleigh—Taylor stability with mass and heat transfer.** Hsieh, D.Y. (Brown Univ., Providence, R.I. (USA). Div. of Applied Mathematics). Aug 1977. Contract EG-77-S-02-4155. 26p. Dep. NTIS, PC A03/MF A01.

The nonlinear Rayleigh-Taylor stability of a liquid-vapor system was studied using a simplified formulation of the problem. The method of multiple scale expansion was employed for the investigation. It was found that when the heat transfer rate is strong enough, the classically unstable system is stabilized by the nonlinear effect and the effect of mass and heat transfer across the interface. The size of the bubbles detached from the interface can also be estimated when the heat transfer rate is moderately strong. The problem was also studied by the variational method, which corroborates basically the same conclusion.

8939 (KAPL-P—4056) **Application of the substructuring method to thermal analysis.** MacMillan, D.B. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA)). 1977. Contract EY-76-C-12-0052. 18p. (CONF-770903—5). Dep. NTIS, PC A02/MF A01.

From ASME energy technology conference on composites in pressure vessels and piping; Houston, Texas, United States of America (USA) (18 Sep 1977).

The development of a general-purpose two-dimensional heat transfer computer program which uses the substructuring approach for organizing the internal details of the calculation, the preparation of input, and the output is described. This computer program has had over 3 years of successful production use. (LCL)

8940 **Unstable conditions of heat transfer on surfaces depleted with respect to vaporization centers.** Avksentyuk, B.P.; Kutateladze, S.S. (Institute of Heat Physics, Siberian Branch, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 96-101(Jul 1977).

The mechanism and stability criterion characterizing the direct transition from free single-phase convection to film-type boiling (third boiling crisis) are considered. Experimental data as to the upper and lower limits of the thermal fluxes at which film-type boiling appears are correlated and generalized.

8941 **Interaction of centers in nucleate boiling.** Chekanov, V.V. (Stavropol). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 101-106(Jul 1977).

This paper describes an experimental apparatus for analysis of the growth of a bubble on a heater, the bubble recurrence rate, etc. from the change in electric signal from a photomultiplier onto whose photocathode the bubble is projected. The adopted measure of the external effect on the vapor-forming center is the change in the first moments of the statistical distribution of the corresponding parameters: growth time, recurrence rate, etc. The greatest effect on single-bubble boiling is that of acoustic waves emitted by the bubble during its growth. In developed boiling, centers separated by distances of the order of the breakaway diameter inhibit one another. Increase in the heat flux increases the correlation of the motion of the interphase boundary above the heater surface. The first crisis occurs when the correlation radius becomes equal to the distance between the centers. It is postulated that heaters with a variable thermal diffusivity along the heat-releasing surface will sustain greater subcritical heat fluxes.

8942 **Hydrodynamic crisis in a two-phase flow.** Nigmatulin, B.I.; Ivandaev, A.I. (Power Institute, Scientific Polytechnical Division, and Mechanics Institute, Moscow State University). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 107-113(Jul 1977).

The phenomenon of hydrodynamic crisis (blocking) in a two-phase flow is studied. The dispersed-ring model for a flow with an effective monodispersed center is used to describe the motion of the flow mixture under near-critical conditions. The basic differential equations of motion for the flow in a channel are described; in particular, differential laws for the variation of the effective diameters of drops in the flow center resulting from mass transfer processes between the components of the mixture are derived. Problems related to the specifics of the model are discussed. Conditions for obtaining a maximal flow rate through the channel are studied as well as the effect of the prior history of the flow on the form of the critical conditions in the outgoing section.

8943 **Expansion characteristics of a bubbling fluidized bed.** Best, R.J.; Yates, J.G. *Powder Technol. ;* **16**: 285-288(1977).

Investigations have been carried out on beds of copper oxide impregnated alumina particles fluidized by air containing low concentrations of sulphur dioxide. It was found that, for a bed of large particles in which a large proportion of the bed was occupied by slowly moving bubbles, the local fractional expansion could best be described by a model hybridizing the simple two-phase and modified two-phase theories of fluidization by means of a distribution function for the bubble size. The simple experimental technique and analysis reported provide an easy means of testing the significance of slowly moving bubbles in a given fluidized bed and also of testing the suitability of any chosen distribution function.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 8442, 8781

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 8781

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 8988, 9523

8944 (BMFT-FB-T—76-64) **New technologies for silicon power devices. Turn-off behavior of thyristors.** Borchert, E. (Allgemeine Elektricitaets-Gesellschaft AEG-Telefunken, Belecke (Germany, F.R.)). Dec 1976. 109p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

The forced commutation behavior of thyristors with an inductive load was studied. The turn-off energy loss (w/sub R/) and other reverse recovery properties are investigated considering the following device parameters: carrier lifetime (tau), total base layers' width (2d), and conductivity type of the main case (s/sub n/: weakly n-doped, i.e., the usual p^+ s/sub n/pn^+ structure, s/sub p/: weakly p-doped, i.e., the complementary p^+ns/sub p/n^+ structure). As to s/sub n/ thyristors, w/sub R/ depends only weakly on 2d but stronger than linearly on tau. Due to the injection of minority carriers into the main base the w/sub R/ of the s/sub n/ thyristor is higher than the w/sub R/ of the corresponding s/sub n/ diode. Contrary to diodes, the turn-off behavior of the s/sub p/ thyristor does not differ essentially from that of the s/sub n/ thyristor. In particular, due to the injection of minority carriers s/sub p/ thyristors exhibit reverse current tail-off similar to s/sub n/ thyristors instead of snap-off which can be exhibited by s/sub p/ diodes.

8945 **Great techniques of circuit-breaking.** Pelenc, Y. (Inst Natl Polytech de Grenoble, Fr). *Rev. Gen. Electr.;* **86**: No. 4, 271-285(Apr 1977). (In French).

The impossibility of determining in advance the behavior of the flashover explains the diversity of technical solutions involved and the major part played in their final adjustment by direct experimentation. The simplicity of the air break type of equipment, its reliability and the lack of overvoltages due to its operation, ensures durable exclusivity in the low voltage field. This success is extended up to 20 kV in the entire lower range of the so-called medium voltages where the air break has given rise to high reliability equipment, especially well suited to operating requirements. However, the old techniques, although well proven, such as the air break (in compressed air or otherwise) and the oil break, have been recently joined by the sulfur hexafluoride and the vacuum break. Among the techniques which compete in the wide high voltage range covering at present 1 to 800 kV, the sulfur hexafluoride break is distinguished by its development speed which appears to be suprioer to all the others. If the future of the vacuum break, the first steps of which started more than 25 years ago, is still uncertain, that of the semiconductor break, although still in the research stage, appears to be highly interesting.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 7803, 7905, 7907, 7908, 7913, 8730

8946 (FE—2461-4) **Industrial application of fluidized-bed combustion. Quarterly technical progress report, April—June 1977.** (Fribourg Univ. (Switzerland). Inst. de Physique). Sep 1977. Contract EX-76-C-01-2461. 15p. Dep. NTIS, PC A02/MF A01.

Consent was provided by ERDA for the following subcontracts: Between Georgetown University and Fluidized Combustion

Comapany; between Fluidized Combustion Company and Pope, Evans, and Robbins, Incorporated; and between Fluidized Combustion Company and Foster Wheeler Energy Corporation. The first two of five construction bid packages, General Construction and Steel Fabrication and Erection, were submitted for ERDA review and approval. The remaining bid packages are Mechanical, Electrical, and Instrumentation. The current plan is for Pope, Evans and Robbins, providing overall construction management, to award and administer the five construction subcontracts. After experiencing initial delays in getting the District of Columbia Board of Zoning Adjustment to hear the project, Georgetown University was able to present the project to the BZA on April 23 and May 10. Final briefs were filed on June 1, 1977 and a favorable decision is expected in the near future. BZA approval must be obtained prior to receiving a building permit. FCC was given authorization in late May to proceed with issuance of prepurchased equipment RFQs. Eighty percent of prepurchased equipment had been released for bid by the end of June. Completion of final design scheduled for the end of May was impacted by three design changes: (a) Substitution of a coal spreader feeder system for the original feed needle design; (b) separation of ash streams; and (c) change of boiler pressure from 250 psig to 625 psig to accommodate possible use of high pressure steam for electricity generation.

8947 (FE—2472-15) **Fluidized-bed combustion: industrial application demonstration projects. Quarterly technical progress report, April 1—June 30, 1977.** Weller, A.E.; Nack, H. (Battelle Columbus Labs., Ohio (USA)). 25 Jul 1977. Contract EX-76-C-01-2472. 11p. Dep. NTIS, PC A02/MF A01.

A subscale experimental unit is being designed and constructed and will be used to develop design information for a 25,000 lb/hr demonstration industrial steam generator using an advanced fluidized-bed combustion process. Nominal design for the subscale unit is a firing rate of 400 lb coal per hour and a bed cross section of approximately 2 square feet. Slippage has occurred in the construction schedule due primarily to late delivery of the combustor/boiler. Construction completion is now scheduled for August 10, 1977. Plans have been made to recover the slippage. Equipment shakedown will begin in August, 1977, and experimental operation will begin in September, 1977.

8948 **Waste air cleaning from roller offset printers with gas as supplementary energy.** Strotbek, G.; Weissbach, H. (Tech Werke der Stadt Stuttgart, Ger). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 5, 191-194(May 1977). (In German).

Washing with water, adsorption on activated carbon, catalytic and thermic combustion are evaluated as waste air cleaning methods. Calculations of heat contributed by gas compared with quantities consumed by the process are presented.

8949 **Principal lines of scientific research on heat transfer in boiler unit furnaces.** Goloviznin, V.P.; Lebedev, V.V. *Energomashinostroenie;* No. 4, 1-3(1977). (In Russian).

The purpose of the proposed research in the USSR in the 1976-1980 period is to design new boiler furnaces fueled by gas and residual fuel oil as well as p.f. in European plants and boiler furnaces to burn brown coal in Siberian plants. Various aspects of this research are briefly discussed.

8950 **Prospects of application of precombustion chamber mixture formation to limit maximum combustion pressures in turbocharged multiple-fuel diesel engines.** Boldyrev, I.V.; Rybinskii, S.V.; Dyatlov, E.G. *Energomashinostroenie;* No. 5, 15-17(1977). (In Russian).

Based on an analysis of the specific features of the laws of heat release, prospects of application of precombustion chamber mixture formation in forced multiple-fuel diesels to limit maximum combustion pressures are indicated.

UNDERGROUND ENGINEERING

8951 (UCRL—13756) **Pursuant to contract No. LLL PO No. 9720605 Lawrence Livermore Laboratory to U.C. Davis.** Cheney, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 May 1977. Contract W-7405-ENG-48. 7p. Dep. NTIS, PC A02/MF A01.

The computer code Putah Petra, a new model for predicting the static behavior of porous rock, is described. This model can account for shear enhanced compaction of the rock. Compared to the old hydrostatic model, SOC, the Putah Petra model predicts much greater compaction near the inner radius of a pressurized borehole and a more rapid decrease in compaction away from the borehole. In the example cited above, the effect of these two differences resulted in a smaller (10 percent) change in borehole radius using the Putah Petra model. Thus material properties estimated by use of the previous model would be roughly 10 percent in error. Many more runs are needed to substantiate this conclusion.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 7950

8952 **New concepts for offshore structures.** Loire, R.; Huvale, L.P. *Tech. Mod.;* **67**: No. 4, 35-39(Apr 1975). (In French).

A new method is proposed for the construction of offshore platforms for installations in 150-200 m deep waters. It is proposed to prepare and equip platforms at standard sites in shallow 25-30 m deep waters near a harbor. A light-weight water-tight reinforced double-walled shell framework (mantle) would first be constructed on an industrial site. It would reproduce the volume of the entire structure and would carry all the service equipment. This mantle would be immersed between two self-lifting platforms each carrying a concrete plant. Then the space between the mantle walls would be filled with concrete. Water would be pumped out from the inner space and replaced with air. A three-deck superstructure would be assembled on top of the mantle, towed in a "retracted" upright position to the construction site, and then lowered, on extensible supports, to the bottom of the sea. These structures are expected to be much more stable than the jacket-type platforms and much easier to set up than the horizontally-towed structures.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 7878

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

8953 (BNL—22896) **Summary of the second international conference on electrostatic accelerator technology.** Wegner, H.E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 23p. (CONF-770527—(Summ.)). Dep. NTIS, PC A02/MF A01.

From 2. international conference on electrostatic accelerator technology; Strasbourg, France (24 May 1977).

A review is given of the history of electrostatic accelerator technology, including a technology assessment of acceleration tubes, vacuum systems, voltage gradients, charging systems, and ion sources. Improvements in the performance of electrostatic accelerators during the last four years and of those currently under construction are discussed. The improved performance has greatly expanded the heavy ion research capabilities of the entire research community. (PMA)

8954 (CONF-770948—1) **Thoughts of accelerator tubes.** Larson, J.D. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From SNEAP conference; Los Alamos, New Mexico, USA (26 Sep 1977).

A brief, subjective review is given of mechanisms that may be limiting electrostatic accelerator tubes to present levels of performance. Suggestions are made for attacking these limitations with the purpose of stimulating the thinking of designers and users of electrostatic accelerators.

8955 (LA—6910-PR) **Intense Neutron Source facility, April 1—June 30, 1977.** Brown, M.C. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-36. 68p. Dep. NTIS, PC A04/MF A01.

The Beam-on-Target accelerator (B-O-T) became operational during this quarter. Initial tests on this system included high-voltage conditioning of the accelerating column, ion source operation in a vacuum environment, operation of the ion source by computer-controlled light links across the high-voltage interface, and a thorough check-out of various safety interlock systems. An increase in the source strength of the INS has been studied, and some of the necessary changes to the ion source, jet target, and beam transport systems are discussed. ERDA is presently considering these impacts. Meanwhile, the INS project has been placed back into the Congressional budget. Preliminary calculations have been undertaken on the possibility of surrounding the irradiation experimental volume with a fission blanket. Further work is cited on understanding the possible geometry for tailoring spectra. The use of a subsonic target in conjunction with the blanket is being studied. New systems for measuring the intense beam density profiles and beam emittances are being evaluated. Other developments during the quarter included the 70-percent Title I review of the INS facility, continuing calculations on neutron shielding, skyshine, and other radiological protection, and further successful operation of the prototype distillation column.

8956 (UCRL—78946) **Environmental neutron spectrum outside the LLL high-intensity 14-MeV neutron facility.** Slaughter, D.R.; Rueppel, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Jun 1977. Contract W-7405-ENG-48. 19p. (CONF-770720—2). Dep. NTIS, PC A02/MF A01.

From 22. annual meeting of the Health Physics Society; Atlanta, Georgia, USA (3 Jul 1977).

The Lawrence Livermore Laboratory has been developing several methods for estimating neutron energy spectra in the field. This work has been motivated by the desire to: (1) verify calculations of spectra and dose to personnel in the environment of neutron sources, (2) provide appropriate calibration factors for dosimeters and dose-rate meters used in the field, and (3) provide physics data for the design of improved neutron shielding around some of our sources. Two approaches were explored. Bonner-sphere measurements were made using various foil-moderator and detector-moderator configurations. In addition, high-resolution measurements were made over a restricted energy range using proton recoil spectrometers including NE 213 liquid scintillators and hydrogen proportional counters. A field measurement using the latter technique is described.

8957 (UCRL—79721) **Thermal-mechanical design of a 150-mA, direct-current, 400-keV accelerator for production of 14-MeV neutrons.** Hanson, C.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Sep 1977. Contract W-7405-ENG-48. 6p. (CONF-771029—20). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, Tennessee, USA (25 Oct 1977).

Several unique accelerator components were designed and built for the Rotating Target Neutron Source Facility at the Lawrence Livermore Laboratory. Particular consideration was given to material selection and cooling design of components because the facility will have a large steady-state beam energy. Components discussed include the system composed of the ion source and 90-deg double-focusing magnet in the high-voltage terminal, a water-cooled 400-keV acceleration column, a pyrolytic-graphite beam collimator, and quick-disconnect beam-tube couplings.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

8958 (ANL-HEP-CP—77-59) **Beam parameters for the Fermilab Collider.** Diebold, R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 15p. Dep. NTIS, PC A02/MF A01.

Formulae are presented for calculating various beam parameters for the Fermilab Main-Ring-on-Doubler Collider. The parameters include: (1) transverse beam size; (2) transverse momentum in the beam; (3) momentum spread; (4) bunch length; (5) beam luminosity; (6) variation of luminosity with crossing angle; (7) length of luminous region; (8) beam-beam tune shift; and (9) scaling equations. Results for specific cases are tabulated. (PMA)

8959 (LA—6894-MS) **Linac beam core modeling from wire-scanner data.** Law, A.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-MS. 24p. Dep. NTIS, PC A02/MF A01.

This study introduces mathematical modeling of accelerator beams from data collected by wire scanners. Details about a beam core $D(x,x',y,y')$ are examined in several situations: (a) for a discretization of the projection into xy-space, a maximum-entropy solution and a minimum-norm solution are developed and discussed, (b) for undiscretized xy-subspace, a two-dimensional Gaussian approximation $D(x,.,y,.) = a \exp[\alpha(x-x_0)^2 + \beta(x-x_0)(y-y_0) + \gamma(y-y_0)^2]$ is obtained by least squares, and (c) for four-dimensional space, the fit of a single Gaussian to data from a succession of wire scanners is investigated.

8960 (UCRL—79958) **Transport of self-focused relativistic electron beams.** Briggs, R.J.; Clark, J.C.; Fessenden, T.J.; Hester, R.E.; Lauer, E.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1977. Contract W-7405-ENG-48. 13p. (CONF-771035—11). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

Experiments with the Astron beam (5 MeV, 0.4 kA) and an FX-25 beam (1.5 MeV, 15 kA) show that the transport of self-focused electron beams in neutral gases is limited by two instabilities. At gas pressures from nearly zero to a few torr, the propagation is dominated by a form of two-stream instability. At higher pressures the resistive hose instability dominates. Between the two regimes, a pressure window exists in which the higher current diode beam propagates stably in both conducting and insulating drift tubes.

8961 **Beam dynamics in a linear electron accelerator with asymmetric focusing coils.** Kozlov, V.P.; Maiorov, Y.K.; Sushinin, Y.V. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 355-356(Mar 1977).

The results of a numerical simulation of the three-dimensional motion of a beam in a linear accelerator are reported for the case in which the symmetry axis of the coils does not coincide with that of the accelerating waveguide. The calculations yield the tolerances on the fabrication and alignment of the focusing elements in linear accelerators and similar devices.

8962 **Effect of cathode focusing and drift apertures on particle trajectories in a microtron.** Zakharov, M.A.; Luganskii, L.B.; Melekhin, V.N.; Prudkovskii, G.P.; Sukhachev, V.Y. (Institute of Physical Problems, Academy of Sciences of USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 357-360(Mar 1977).

A hybrid calculation method is described. The radial and vertical motions of the particles near the cathode are calculated with an electrolytic bath; the subsequent three-dimensional motion is calculated on a computer. Incorporation of the particle focusing which occurs near the emitter, which is in a recess in the cover of the resonator, makes it possible to find acceleration conditions of practical interest. Under these conditions the working area of the emitter and the relative number of accelerated particles are increased to levels 2—3 times those corresponding to the usual conditions.

8963 **Electromagnetic effects in resonance processes in colliding beams.** Bazhanov, V.V.; Pron'ko, G.P.; Solov'ev, L.D. (Institute of High Energy Physics, Serpukhov). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 1-10(Jan 1977).

A method is considered for allowing for electromagnetic effects in the production of heavy narrow resonances in e^+e^- annihilation. The method is based on a low-energy theorem, unitarity, and dispersion relations. Expressions are obtained with allowance for radiative processes for the total resonance-production cross section and the cross section of two-particle channels (for the latter, radiative corrections are also present in the interference term of the cross section). The universality of the electromagnetic corrections in the cross sections of other channels is discussed. Expressions are obtained for the width of the resonance decay into a leptonic pair and a photon under various experimental conditions.

8964 (ORNL-tr—4394) **Excitation of resonances traversed by the beam during acceleration in the CSS by multipilar components tolerances on these components.** Chabert, A.; Gendreau, G. 5 Apr 1976. Translated by E.G. Silver of GANIL—76-32. 42p. Dep. NTIS, PC A03/MF A01.

Perturbation theory is used to calculate beam trajectories and the effects of various resonances in the separated sector cyclotron (CSS) of GANIL. The analysis uses the Hamiltonian of the motion and phase-amplitude variables. A general table of tolerances is provided. (PMA)

AUXILIARIES AND COMPONENTS

8965 (ANL-HEP-PR—77-61) **ZGS beam transport for transverse or longitudinally polarized protons.** Colton, E.; Auer, I.P.; Beretvas, A. (Argonne National Lab., Ill. (USA)). 11 Aug 1977. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

A combination of dipole magnets and a superconducting solenoid is utilized to transform the spin direction of transversely polarized protons from the Argonne ZGS for use in proton-proton scattering experiments.

8966 (LBL—5350) **Development of large high current density superconducting solenoid magnets for use in high energy physics experiments.** Green, M.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1977. Contract W-7405-ENG-48. 273p. Dep. NTIS, PC A12/MF A01.

Thesis.

The development of a unique type of large superconducting solenoid magnet, characterized by very high current density windings and a two-phase helium tubular cooling system is described. The development of the magnet's conceptual design and the construction of two test solenoids are described. The successful test of the superconducting coil and its tubular cooling refrigeration system is presented. The safety, environmental and economic impacts of the test program on future developments in high energy physics are shown. Large solid angle particle detectors for colliding beam physics will analyze both charged and neutral particles. In many cases, these detectors will require neutral particles, such as gamma rays, to pass through the magnet coil with minimum interaction. The magnet coils must be as thin as possible. The use of superconducting windings allows one to minimize radiation thickness, while at the same time maximizing charged particle momentum resolution and saving substantial quantities of electrical energy. The results of the experimental measurements show that large high current density solenoid magnets can be made to operate at high stored energies. The superconducting magnet development described has a positive safety and environmental impact. The use of large high current density thin superconducting solenoids has been proposed in two

high energy physics experiments to be conducted at the Stanford Linear Accelerator Center and Cornell University as a result of the successful experiments described.

8967 (ORNL/TM—5419) **Calculations pertaining to the design of a prebuncher for a 150-MeV electron linear accelerator.** Alsmiller, R.G. Jr.; Alsmiller, F.S.; Barish, J.; Lewis, T.A. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 53p. Dep. NTIS, PC A04/MF A01.

Results derived from calculations based on a one-dimensional ballistic model are presented to indicate the extent to which a current pulse of 150-keV electrons containing 1 μC of charge and having a duration of 15 nsec (FWHM) can be bunched by a combination of accelerating and decelerating voltage gaps followed by a drift space. To be useful, the bunched current must be accelerated by an existing accelerator (ORELA), so the calculated results include estimates (upper and lower limits) of the fraction of the bunched beam that will be accelerated. It is found that with 8 voltage gaps the 15-nsec (FWHM) pulse can be reduced to a pulse of approximately 4 nsec (FWHM) in a length approximately 400 cm and that approximately 50% of this bunched pulse will be accelerated by ORELA. The fraction of the bunched pulse that will be accelerated is approximately the same as that for an unbunched pulse.

8968 (SAND—77-1324c) **Super power generators.** Martin, T.H.; Johnson, D.L.; McDaniel, D.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 24p. (CONF-771035—5). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

PROTO II, a super power generator, is presently undergoing testing at Sandia Laboratories. It has operated with an 80 ns, 50 ns, 35 ns, and 20 ns positive output pulse high voltage mode and achieved total current rates of rise of 4 x 10^{14} A/s. The two sided disk accelerator concept using two diodes has achieved voltages of 1.5 MV and currents of 4.5 MA providing a power exceeding 6 TW in the electron beam and 8 TW in the transmission lines. A new test bed named MITE (Magnetically Insulated Transmission Experiment) was designed and is now being tested. The pulse forming lines are back to back short pulse Blumleins which use untriggered water switching. Output data showing a ten ns half width power pulse peaking above one terrawatt were obtained. MITE is a module being investigated for use in the Electron Beam Fusion Accelerator and will be used to test the effects of short pulses propagating down vacuum transmission lines.

8969 (SAND—77-1365C) **Power flow studies of magnetically insulated lines.** McDaniel, D.H.; Poukey, J.W.; Bergeron, K.D.; VanDevender, J.P.; Johnson, D.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 10p. (CONF-771035—3). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

The designs for relativistic electron beam accelerators with power levels of 20 to 100 TW are greatly restricted by the inductance of a single diode of reasonable size. This fact leads to modular designs of very large accelerators. One concept uses several small insulators at a large radius arranged around the accelerator center. The total effective inductance is then low, but the energy must then be transported by self-magnetic insulated vacuum lines to the target volume. A triplate vacuum line configuration eases many mechanical support problems and allows more A-K gaps or feeds to be packaged around a given radius. This type of vacuum transmission line was chosen for initial experiments at Sandia. The experiments were conducted on the MITE (Magnetically Insulated Transmission Experiment) accelerator. The water pulse forming lines are connected to a vacuum triplate line through a conventional stacked insulator. Diagnostics on the experiment consisted of: (1) input V; (2) input I; (3) I monitors at the input, middle, and output of both the center conductor and ground plane of the transmission line; (4) magnetic energy analyzer to view peak electron energy in the A-K gap; (5) calorimetry; and (6) Faraday cups to look at electron current flowing across the transmission line. The main goal of the experiment is to obtain input impedance of the transmission line as a function of voltage and to measure electron loss currents. These measurements are compared to theoretical models for the input impedance and energy losses.

ION SOURCES

8970 (LA-UR—77-2113) **Experiments with a Dudnikov-type H source.** Allison, P.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-770940—3). Dep. NTIS, PC A02/MF A01.

From Symposium on the production and neutralization of negative hydrogen ions and beams; Upton, New York, USA (26 Sep 1977).

Operating characteristics of the ion source described were previously reported. It uses a Penning discharge to produce H ions by the surface-plasma principles and was constructed according to the design details presented by Dudnikov. Arc power must be held relatively constant at about 50 watts to maintain stable operation, and this occurs for an indicated cathode temperature of 500°C. Within this limitation the source may be operated continuously at 2 mA or pulsed at over 100 mA, as measured with a Faraday cup at the exit of a 90°, n = 0.85, 8-cm radius focusing magnet which also provides the magnetic field for the arc region. Recent work concentrated on studying the beam-noise behavior and on measuring the emittance. Emittance was found to vary widely depending on operating conditions, but it is comparable with the values reported by Dereviankin et al for a noisy, beam extracted from their source of this design.

EXPERIMENTAL FACILITIES AND EQUIPMENT

8971 (ANL-HEP-CP—77-50) **Experimental Hall design considerations.** Ayres, D.S.; Berley, D.; Chen, K.W.; Carrigan, R.; Cox, B.; Kalbfleisch, G.; Gustafson, H.R.; Jones, L.W. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 29p. Dep. NTIS, PC A03/MF A01.

General requirements for experimental halls at the Fermilab Collider are set forth, and specific designs for two halls are presented, one for the Detector Group's large "W detector" and the other for several smaller setups and for ep experiments. The physics which cannot be studied with the W detector is surveyed, and it is recommended that the second area incorporate a transposed geometry to allow small angle experiments. The most important recommendations are (1) that the halls have good access and the possibility of changing entire setups during short shutdowns, (2) that both equal energy (anti pp) and unequal energy (pp, ep) experiments be accommodated, (3) that construction take place during the superconducting ring installation, (4) that the halls incorporate assembly areas in which detectors can be built and serviced during machine operation and (5) that detailed design, including radiation safety calculations and muon background measurements, begin immediately. Some basic questions concerning the nature of the experimental halls needed for colliding beam experiments at Fermilab are discussed. General requirements and design considerations are dealt with first, followed by specific proposals for the layout of actual halls.

8972 (ANL-HEP-CP—77-52) **pp collider construction scenario.** Ayres, D.S.; Diebold, R.; Carrigan, R.; Johnson, D.E.; Slaughter, J. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

In order to bring the Fermilab proton-proton colliding-beam facility into operation at the earliest possible time, close coordination between the various aspects of the construction is essential. A possible scenario for how the installation might proceed is presented, and some important consequences for planning in the immediate future are discussed. Some important conclusions which can be drawn from the scenario are presented.

8973 (LA—6884-M) **QAL and the analyzer task.** Kellogg, M.; Minor, M.M.; Shlaer, S.; Spencer, N.; Thomas, R.F. Jr.; van der Beken, H. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 57p. Dep. NTIS, PC A04/MF A01.

This manual discusses the analyzer task used in conjunction with the Q general-purpose data acquisition system. The analyzer is a task written by the experimenter to specify the data he wishes to acquire and to perform processing operations on those data. The Q Analyzer Language (QAL), a special-purpose language used to specify the data to be acquired, is described as well as the operation of the program that translates this language into a working analyzer.

8974 (LBL—6716) **Design of solenoid magnets using Legendre functions.** Green, M.A.; De Olivares, J.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 13p. (CONF-770842—13). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The magnetic field in a solenoid or Hemholtz type magnet can be represented by a Legendre function power series. Using modern computers, one can design the coils of a solenoid or Hemholtz magnet in order to produce a field with desired characteristics. The Legendre function presentation can be used with certain iron configurations as well. The design of solenoid correction coils by use of this technique is presented. 6 figs., 6 tables.

8975 **Novel Faraday cup for the simultaneous observation and measurement of ion-beam currents.** Wei, C.; Seidman, D.N. (Department of Materials Science and Engineering and the Materials Science Center, Cornell University, Bard Hall, Ithaca, New York 14853). *Rev. Sci. Instrum.;* **48**: No. 12, 1617-1620(Dec 1977).

A novel Faraday cup is described which allows the simultaneous observation and measurement of ion-beam currents. The Faraday cup is constructed around a Galileo channel electron multiplier

array (CEMA), which serves as the basis of an internal image intensification system (a gain of $>10^4$) for the observation of the ion beam; the CEMA also acts as a collector for the ion current which is measured by a Keithley 602 electrometer. The ion current is integrated by a simple and inexpensive dosimeter; the electronic circuit for the dosimeter is described. The application of the Faraday cup to the observation and measurement of a 30-keV Ar^+ ion beam is presented as an illustrative example. We have also employed this Faraday cup to observe and measure 30-keV Cr^+, Mo^+, or W^+, and 18-keV Au^+ ion beams employed for the in situ irradiation of field-ion microscope specimens.

8976 **Tevatron.** Wilson, R.R. (Fermi National Accelerator Laboratory, Batavia, Illinois). *Phys. Today;* **30**: No. 10, 23-31(Oct 1977).

With a ring of superconducting magnets the Fermilab accelerator will double its proton energy and reduce its electrical power consumption, and will offer the opportunity for colliding-beam experiments.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 8996, 9072, 9088, 9121

8977 (AD-B—011943) **List of military and civil defense radiac devices.** (Defense Nuclear Agency, Washington, D.C. (USA)). 1 Jul 1976. 42p. (DNA(AR)—124-3M-Rev). NTIS PC A03/MF A01.

A compilation of radiac devices currently available to the Department of Defense is presented. The list is separated into rate meters and support equipment, dosimeters and chargers, sampling devices, calibration equipment, and systems and kits. Each item includes nomenclature, classification, federal stock number, cost, sponsoring agency and a general description of the item.

8978 (ORO—3924-29, pp 25-26) **Development of a large position-sensitive gas ionization chamber.** Adler, L.; Rogers, R. Jul 1977.

In Angular momentum effects in nuclear reactions. Progress report, August 1, 1976—July 31, 1977.

The basic design of a position-sensitive gas ionization chamber is described. It spans an angle of 97° and fits inside at 15″ radius scattering chamber. Construction features and preliminary performance data are discussed. 2 figures, 1 table. (RWR)

8979 **Secondary processes in gas-filled counters. II.** Peskov, V.D. (Institute of Physical Problems, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 335-339(Mar 1977).

The quantum yield of secondary electrons from the cathode of the ionization chamber and a gas-filled counter is studied experimentally as a function of the field. The mechanism for the inverse electron diffusion is also studied. At current densities $j>10^{-10}$ A/cm² in ionization chambers sinusoidal oscillations of the current similar to the recombination oscillations in vacuum diodes are observed. It is shown that false pulses are caused in gas-filled counters primarily by resonant photons; to a much lesser extent, false pulses are also caused by ions. As a rule, the metastable atoms decay in the volume of the counter.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 8049, 8050, 9158

HIGH ENERGY PHYSICS INSTRUMENTATION

8980 **High proton polarization achieved with a (Yb, Y) $(C_2H_5SO_4)_3$ x $9H_2O$ spin refrigerator in a nonuniform magnetic field.** Button-Shafer, J.; Lichti, R.L.; Potter, W.H. (University of Massachusetts, Amherst, Massachusetts 01003). *Phys. Rev. Lett.;* **39**: No. 11, 677-680(12 Sep 1977).

Proton polarization of approximately 65% has been achieved with the University of Massachusetts "spin refrigerator" in a nonuniform 1.07-T field at 1.25 K. The free protons in (Yb, Y)$(C_2H_5SO_4)_3$ x $9H_2O$ are polarized through sample rotation at 100—200 rps. Results represent the first confirmation of high polarization predicted by a single-Yb-ion interaction model since the original proposals of Jeffries and Abragam. The polarized proton target, with length equivalent to 9 cm of liquid hydrogen, will be utilized in studies of strange particles.

8981 **Use of semiconductor detectors in high energy physics.** Akimov, Y.K. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 80-91(Jan 1977).

Various methods of detecting nuclear particles and γ rays in high energy physics by means of semiconductor detectors are described. The principle attention is devoted to questions related to use of semiconductor detectors in study of particle scattering at small momentum transfers. Spectrometry of x rays and γ rays in experiments with beam-particle stoppings in the target is discussed. Examples are given of use of semiconductor detectors simultaneously as a target. Appreciable space is given in the review to details of experimental technique.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 7899, 8053, 8054, 8055, 8056, 8057, 8058, 8116, 8117, 8118

8982 (BM-RI—8242) **Principles of ionization smoke detection. Development of a new sensor for combustion-generated submicrometer particulates.** Litton, C.D.; Hertzberg, M. (Bureau of Mines, Pittsburgh, Pa. (USA). Pittsburgh Mining and Safety Research Center). 1977. 25p. GPO.

A new prototype ionization-attachment fire detector was developed by the Bureau of Mines for detecting combustion-generated submicrometer particulates. It is much more sensitive than the conventional ionization smoke detector, and it has the following added features: (1) A primary charging current of unipolar air ions is generated by a gold-coated, radioactive center electrode of a cylindrical diode. (2) Submicrometer particulates are flowed axially through the unipolar cloud where they acquire charge. The charged particles impinge upon a third electrode, located downstream, resulting in a current which is directly proportional to the particulate concentration. (3) Additional electrodes analyze the particulates in terms of their mobility and thus determine their size distribution. (4) A filter and cyclone assembly protect the ionization chamber against ambient dust. An analysis of conventional ionization smoke detector performance is also presented in terms of source strength, chamber geometry, and applied potential.

8983 (PB—267106) **Improved nuclear gage development - phase i and ii. Interim report.** Chan, E.L.; Champion, F.C.; Castanon, D.R.; Chang, J.C.; Hannon, J.B. (California State Dept. of Transportation, Sacramento (USA). Transportation Lab.). Sep 1976. 227p. (CA-DOT-TL—2857-1-76-45). NTIS PC A11/MF A01.

This report contains Phase I and II of an investigation covering the design and construction of a prototype nuclear-moisture-density backscatter gage. Gage development was based upon the analysis of several factors which affect gage performance. This research indicated that the prototype gage measurements are approximately equivalent to measurements obtained by a commercial transmission gage. The implication of this research finding concerns the qualification of the backscatter test method as a valid, reliable, and expedient procedure for determining in-situ soil conditions.

8984 (PB—268098) **Precision of the relative compaction test using nuclear gages. Final report.** Benson, P.E.; Kuhl, D.J. (California State Dept. of Transportation, Sacramento (USA). Transportation Lab.). Dec 1976. 47p. (CA-DOT-TL—1153-5-76-65). NTIS PC A03/MF A01.

Precision statements for the relative compaction test under varying conditions are given. The precision of the in situ density determination is based on application of Test Method No. Calif. 231-F using nuclear gages and a sampling technique called the area concept. Maximum wet density precision is based on ASTM-D1557-70. A model for nuclear gage repeatability is established and the adequacy of current calibration procedures is evaluated. The precision of ASTM-D1557-70 using California operators is reported. A number of pertinent variance components are isolated with respect to the overall relative compaction variance. Also, the variation of density determinations within a relatively uniform area is given for treated and untreated soils. Precision statements for a number of California concrete and aggregate test methods are also summarized.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 7821, 7839, 7905, 7923, 8010, 9004, 9121

8985 (CONF-771031—6) **New small angle neutron scattering (SANS) instrument at ORNL using a position sensitive area detector.** Child, H.R.; Spooner, S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 28p. Dep. NTIS, PC A03/MF A01.

From 21. conference on analytical chemistry in energy technology; Gatlinburg, Tennessee, USA (4 Oct 1977).

This paper describes the construction and operation of the small-angle neutron scattering instrument which has been set up at the Oak Ridge Research Reactor at ORNL. Motivation for work on this system to date has been the demonstration of the feasibility of the Borkowski-Kopp position-sensitive area detector and the use of pyrolytic graphite monochromating crystal pairs for small angle neutron scattering research. For a relatively modest cost, a serviceable experimental capability has been achieved. It is planned that some of the experience developed at this facility will be incorporated in a proposed large-scale apparatus at the High Flux Isotope Reactor (HFIR) and that this facility will continue in use for preliminary scattering tests.

8986 **Scan—playback corrections.** Trussell, H.J.; Breedlove, J.R. Jr. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Appl. Opt.;* **16**: No. 9, 2359-2360(Sep 1977).

Corrections for playback aperture effects in image digitizers are discussed theoretically.(AIP)

8987 **Two-photon spectrometer based on flashlamp-pumped dye lasers.** SethuRaman, V.; Small, G.J.; Yeung, E.S. (Iowa State University, Department of Chemistry and Ames Labortory—ERDA, Ames, Iowa 50011). *Rev. Sci. Instrum.;* **48**: No. 11, 1436-1439(Nov 1977).

We describe here a two-photon spectrometer that utilizes two independently tuned, flashlamp-pumped dye lasers, and the associated detection electronics for the determination of the temporal profile of the two lasers (FWHM≅200 ns) and the fluorescence pulse following two-photon excitation. This spectrometer allows for proper normalization of the observed signal to the laser power. Procedure for the extraction of relative cross sections for two-photon absorption is described, and a spectrum obtained for a solution of naphthalene in benzene is presented.

8988 (LA-tr—77-31) **Electronic plug-in system for quantitative microscopy decimal digital indicator unit 47 74 43: description of operation.** 1977. Translation of German report. 16p. Dep. NTIS, PC A02/MF A01.

A measured value which is input as the length of a gate pulse is converted into digital information by counting the pulses of a quartz oscillator during this gate pulse. The final counter value, which thus corresponds to the measured value, is transmitted to the data output in BCD and binary code by means of intermediate storage, and after decimal decoding, the reading is given with digital display tubes. Optionally, the measured values may be averaged individually or over 2 to 256 measured values. The unit also takes care of synchronizing the data processing with a desk top control unit to which it is connected. If necessary, this plug-in unit can also be used as an autonomous measurement instrument; for this reason, it is also equipped with a sawtooth digitizer which creates an appropriate pulse length from the measured value which is in the form of direct current. Circuit diagrams are presented and discussed.

8989 **Investigating the possibility of measuring the flowrate of dust-laden gas by a longitudinally swept cylindrical hot-wire anemometer.** Lelchuk, V.L.; Etkin, V.B. *Therm. Eng. (USSR) (Engl. Transl.);* **22**: No. 10, 76-79(Oct 1976).

The characteristics of a hot-wire anemometer, in which the heater and thermocouple are fitted inside a metal cylinder which acts as the heat transfer element, were investigated. It is concluded that this kind of anemometer is suitable for use in dust-laden gases, for example in power stations.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 7945, 8028, 8053, 8054, 8055, 8056, 8057, 8058, 8116, 8117, 8118

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 8991

8990 (MHSMP—77-6) **Particle size characteristics of pyrotechnic powders.** Duncan, A.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1976. Contract EY-76-C-04-0487. 7p. Dep. NTIS, PC A02/MF A01.

Pyrotechnic powders supplied by Al Heckes of Sandia Laboratories, Albuquerque, have been characterized using a semi-automatic microscopy technique (Zeiss Analysis) to measure particle size distribution and specific surface area by both gas adsorption (static BET apparatus) and permeametry (Fisher Sub Sieve Sizer). Photomicrographs, specific surface area and mean particle sizes are given.

NUCLEAR

REFER ALSO TO CITATION(S) 9013

8991 (AD-A—040339) **Evaluation of large pyrotechnic arrays for nuclear burst simulation. Summary report.** Rittenhouse, C.T. (Unidynamics/Phoenix, Inc., Ariz. (USA)). 28 Jun 1976. Contract DAAG39-76-C-2002. 52p. NTIS PC A04/MF A01.

The following topics are discussed: smoke plume characterization; smoke dispersal methods; ignition aid studies; provision of pyrotechnic samples to ballistic research laboratories; investigation of alternate pyrotechnic burning configurations; selection and evaluation of candidate pyrotechnics; testing of large pyrotechnic arrays; conclusions and recommendations; pyrotechnic formulations; and comparative summary of pellet test data.

8992 (PB—268108) **Ready I system for the UNIVAC 1108 weapons preparation program. Final report.** (General Services Administration, McLean, Va. (USA). Mathematics and Computation Lab.). Apr 1977. 31p. (GSA/FPA/MCL-TM—234-Rev-2). NTIS PC A03/MF A01.

This technical manual contains detailed instructions for users of the Weapons Preparation Program. It contains information concerning the several options of the program, input-output formats, and operating procedures.

CIVIL USES

8993 (NVO—187) **Project Rulison: well plugging and site abandonment. Final report.** (Energy Research and Development Administration, Las Vegas, Nev. (USA). Nevada Operations Office). Sep 1977. 46p. (PNE-R—70). Dep. NTIS, PC A03/MF A01.

This document is designed to be used in conjunction with NVO 174 (Rev. 1), the Project Rulison Well Plugging and Site Abandonment Plan, August 1976. NVO 174 (Rev. 1) describes in detail the methods and procedures that were to be used in implementing a plugging and abandonment procedure for the Rulison wells and site. This final report compares the planned actions with the actual disposition of the various tasks and operations. Those activities which departed substantially from the original plan of operation are described along with the operations that occurred as planned. The disposal of all radiological materials is discussed comprehensively in the Rulison Radiation Contamination Clearance Report PNE-R-68 dated June 1977 by the Eberline Instrument Corporation.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

8994 **Temperature feedback in a stratospheric model.** Luther, F.M.; Wuebbles, D.J.; Chang, J.S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Geophys. Res.;* **82**: No. 31, 4935-4942(20 Oct 1977).

Perturbing the stratospheric composition affects the stratospheric temperature profile via the radiation balance. Changes in temperature affect chemical reaction rates, which in turn feed back on stratospheric composition. The effect of temperature feedback on ozone concentration has been investigated for three types of perturbations: (1) stratospheric injection of NO/sub x/, (2) release of fluorocarbons, and (3) doubling CO_2. Temperature feedback had approximately a 10% restoring effect on ozone for small ozone reductions because of either stratospheric NO/sub x/ injection or release of fluorocarbons. Doubling CO_2 concentrations increased total ozone by 2.9%. Calculations of ozone reduction including temperature feedback were as much as 20% less than fixed temperature calculations using the U.S. Standard Atmosphere temperature profile.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 7881, 8043, 8948, 9011, 9012, 9121

8995 (N—77-21738) **Photochemical air pollution. The origin of photochemical air pollution: the situation in the Netherlands and elsewhere.** Nieboer, H.; Vanham, J. (Nijverheidsorganisatie TNO,

Delft (Netherlands). Centraal Lab. TNO). Aug 1975. 77p. (In Dutch). (TNO-CL—75/64). NTIS PC A05/MF A01.

Photochemical air pollution from sunlight reacting with primary pollutants results in a number of secondary products causing chronic and acute effects in man, plants, and animals. The role of ozone concentration is discussed, as well as that of the contribution of typical emissions. Meteorological parameters are taken into account.

8996 (ORNL—5171, pp 246-260) **Detection principles.** Gammage, R.B.; Ashraf, J.; Beach, J.L. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Progress is reported on the development of low-level radiation monitors for use in environmental monitoring and on the development air monitors for monitoring nonnuclear energy-system pollutants in the environment, with emphasis on monitoring carcinogenic polycyclic aromatic hydrocarbons (PAH) produced in coal conversion processes. Measurements of low-energy proton energy loss in hydrocarbon gases are reported.

8997 (PB—267096) **Study of gasoline vapor emission controls at small bulk plants. Final report.** Bryan, R.J.; Jacobson, W.O.; Saakaida, R.R.; Bakshi, P.S. (Pacific Environmental Services, Inc., Santa Monica, Calif. (USA)). Oct 1976. Contract EPA-68-01-3156. 241p. NTIS PC A11/MF A01.

The purpose of this report is to provide information to operators of gasoline bulk plants and to air pollution control authorities regarding sources of emissions of hydrocarbon vapors from bulk plants and the effectiveness and costs of available technology for control of these emissions. The study was limited to bulk plants distributing less than 76,000 liters (20,000 gallons) of gasoline daily. Pacific Environmental Services, Inc., under an EPA contract, conducted an independent evaluation of the impact of hydrocarbon emission controls on bulk plants. PES developed a data base from a survey of bulk plants in three Air Quality Control Regions. Data base was used to define a typical bulk plant operation and estimate the uncontrolled hydrocarbon emissions. Results indicated that the typical bulk plant is small (15,000 liters or 4,000 gallons per day) and that breathing and fugitive emissions are significant factors in addiiion to transfer emissions which EPA regulations control. PES surveyed available hydrocarbon emission control techniques, investigating the most promising techniques for cost, efficiency, development status and bulk plant applicability.

8998 (PB—267432) **Environmental conditions in U.S. copper smelters.** Wagner, W.L. (National Inst. for Occupational Safety and Health, Cincinnati, Ohio (USA)). Apr 1975. 42p. (DHEW/PUB/NIOSH—75/158). NTIS PC A03/MF A01.

An overview is presented of environmental conditions in the copper smelters operating in the United States through 1973 with data collected from surveys of the eight primary smelters. Airborne concentrations are included for arsenic, lead, zinc, copper, cadmium, molybdenum, and sulfur dioxide. Concentrations determined in the urine of smelters are included for arsenic, lead, copper, and cadmium. Airborne concentrations of sulfur dioxide were relatively high and variable in all smelters whereas concentrations of lead, zinc, cadmium, and molybdenum were consistantly low. Airborne copper concentrations were relatively high in certain areas but occurred mostly as a non-respirable dust. Urine concentrations were not significantly higher than normal for arsenic, lead, and cadmium. The pararosaniline method and the hydrogen peroxide method are described for determining sulfur dioxide in the atmosphere.

8999 (PB—267566) **Fiscal year 1975/control technology research programs abstracts.** Dixon, K.; Holte, H. (Vitro Labs., Silver Spring, Md. (USA)). Nov 1976. Contract EPA-68-01-0612. 266p. NTIS PC A12/MF A01.

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise, and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment -- air, water, and land. The Vitro Laboratories contribute to this multidisciplinary focus through programs engaged in studies on the effects of environmental contaminants on the biosphere, and a search for ways to control pollutants and/or to mitigate their effects. This report contains abstracts of energy-environment program tasks which have been designed to carry out the intent of the above stated objectives.

9000 (PB—267567) **Fiscal Year 1975/health and environmental effects research program abstracts.** Dixon, K.; Holte, H. (Vitro Labs., Silver Spring, Md. (USA)). Nov 1976. Contract EPA-68-01-0612. 392p. NTIS PC A17/MF A01.

This report includes SSIE (Smithsonian Science Information) Abstracts pertaining to the FY 1975 Interagency Energy/Environment Research, Development and Demonstration Program being coordinated and managed by EPA's Office of Energy, Minerals, and Industry. The Abstracts are organized by major health and ecological research categories. This volume includes research being accomplished by EPA and its laboratories as well as a number of other participating agencies of the Federal Government.

9001 (PB—268239) **Factors affecting the collection efficiency of atmospheric sulfate. Final report, Apr 1975—Nov 1976.** Coutant, R.W. (Battelle Columbus Labs., Ohio (USA)). May 1977. Contract EPA-68-02-1784. 99p. NTIS PC A05/MF A01.

Factors that influence the collection and measurement of atmospheric sulfate were investigated. Special emphasis was given to those factors that cause the formation of extraneous sulfate during the sampling process. The factors considered were filter type and composition, ambient SO_2 concentration, temperature, relative humidity, ambient gas composition, sampling time and rate, storage time and conditions, and the presence of potential oxidation catalysts in the particular catch. The approach of the investigation was twofold. After conducting an extensive laboratory program to identify and quantify significant sulfate generating interactions, a brief field study was performed to test the significance of the laboratory observations under typical field operating conditions. The results of this investigation indicated that the most significant cause of sulfate sampling error is the interaction of basic filter components with ambient SO_2. This interaction is affected by ambient atmospheric conditions. A relationship based on established chemistry was developed for the prediction of sulfate error caused by this interaction. Recommendations of filter media appropriate for ambient sulfate monitoring and further development of a methodology are included.

9002 (PB—268242) **Emission inventory capital district (New York) air quality maintenance area. Final report.** Easterly, T.W. (Capital District Regional Planning Commission, Albany, N.Y. (USA)). May 1977. Contract EPA-68-02-2314. 54p. NTIS PC A04/MF A01.

This project provides a disaggregated particulate and sulfur dioxide emission inventory suitable for use in both base year and projection year modeling required for the Capital District Air Quality Maintenance Area. The allocation and projection methodology is essentially that of volumes 7 and 13 of the Guidelines for Air Quality Maintenance Planning and Analysis series published by USEPA. The published report contains county and AQMA level estimates of residential and non-automotive transportation emissions for the base and projection years. It also includes the expected growth or decline of commercial and industrial emissions.

9003 (PB—268361) **Sulfates in the atmosphere. A progress report on project MISTT (midwest interstate sulfur transformation and transport). Interim report, Jun 1974—Jun 1976.** Wilson, W.E.; Charlson, R.J.; Husar, R.B.; Whitby, K.T.; Blumenthal, D. (Environmental Sciences Research Lab., Research Triangle Park, N.C. (USA)). Mar 1977. 40p. (EPA—600/7-77/021). NTIS PC A03/MF A01.

The size and sulfate content of atmospheric aerosols and the rate and mechanisms for sulfate formation from sulfur dioxide in power plant plumes are reviewed. Emphasis is given to results from the recent USEPA study, Project MISTT (Midwest Interstate Sulfur Transformation and Transport). The rate of conversion of sulfur dioxide to sulfate aerosol in power plant plumes is low near the point of emission, but increases to several percent per hour as ambient air mixes with the plume. Tall stacks reduce ground-level concentrations of sulfur dioxide, resulting in a reduction of the amount removed by dry deposition. In urban plumes, which are well-mixed to the ground near the source, sulfur dioxide is removed more rapidly by dry deposition. Thus, tall stacks increase the atmospheric residence time of sulfur dioxide, which leads to an increase in atmospheric sulfur formation. These sulfate aerosols may be transported over distances of several hundred kilometers and produce air pollution episodes far from the pollution source.

9004 (UCID—17513) **Instruction manual for Gunn-diode microwave cavity ammonia monitor.** Hrubesh, L.W.; Maddux, A.S. Jr.; Johnson, D.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jun 1977. Contract W-7405-ENG-48. 79p. Dep. NTIS, PC A04/MF A01.

The Gunn-diode microwave cavity instrument is a self-contained (the vacuum pump is external) microwave spectrometer for the specific detection and monitoring of ammonia gas in air. A solid state microwave source is used together with a high-Q resonant microwave cavity which is both the frequency selecting device for the source and the sample container through which the sampled gases pass. The ammonia absorption transition at 23,870.1 MHz is monitored continuously with this instrument. The monitoring frequency is stable to one part in 10^9 so that the system only responds to NH_3 absorption--there are no known interfering gases. The instrument was designed for simple operation and easy calibration. Except for the calibration procedure, the instrument operates automatically from turn-on. A four-digit readout is supplied on the front panel and it reads the concentration of ammonia directly in parts-per-million over a range of from 0.00 to 20 ppM. A 0 to 10 volt output is also

available at the rear panel for recording data on an external recorder.

9005 Equilibrium solubility of trace atmospheric sulphur dioxide in water and its bearing on air pollution injury to plants. Hocking, D. (Northern Forest Research Centre, Edmonton, Alberta); Hocking, M.B. *Environ. Pollut. (London);* **13**: No. 1, 57-64(May 1977).

Experimentation with, and understanding of, sulfur dioxide injury to plants may be improved with better knowledge of the chemical dynamics of sulfur dioxide dissolution. The paper computes curves of chemical equivalence between SO_2 in air and in water, over the range of temperatures and SO_2 concentrations in air that bracket those for injury to plants; tabulates relationships among the ionic and molecular species that occur and finds excellent agreement with the fragmentary experimental data that exist. On the basis of the results and data in litt., it is inferred that dissolved but unreacted SO_2 is the most active species for initial plant injury in air pollution episodes.

9006 Stability of stratospheric ozone and its importance. Scorer, R.S. (Imperial Coll. of Science and Tech., London). *Atmos. Environ.;* **11**: No. 3, 277-281(1977).

Discussion of the evidence, theories, and issues surrounding theories of ozone depletion leads to the following standpoints: The chemical reactions are not completely known and further knowledge is likely to reveal a system less susceptible to effects of pollution than present theories suggest. The dynamical models, being based on the representation of vertical transfer by a diffusion mechanism, are fundamentally wrong and because of this they are not appropriate for the prediction of the effects of pollution even if they are useful for understanding average conditions. The amount of monitoring necessary for a significant improvement in methods of predicting the effects of pollution is such that it is unlikely to be undertaken for several decades. The effects of ozone depletion are not likely to be observable. The connection between ozone amount and skin-cancer is not such as to justify any prediction of an effect of ozone depletion. The assumptions behind welfare and pollution control have moved recently to a point where evolution will be, and perhaps already has been, retrograde, and there is no justification for action against chlorofluorocarbons as aerosol propellants except by pricing designed to reduce extravagant use of non-renewable resources. The attention of those concerned with long term problems of our overpopulated world should be directed against dependence on consumption of non-renewable resources and on structures built without consideration of how they will circumscribe the choices of our descendants. The ozone depletion scares have attracted undue attention since they concern only a tiny minority which can perfectly well take care of itself.

9007 (BNWL-tr—260) **Single and complex action of airborne ammonia and hydrogen sulfide on small test animals (rats) under various environmental conditions. 1st communication: The action fo ammonia.** Stolpe, J.; Sedlag, R. Translated from *Arch. Exp. Veterinaermed.;* **30**: No. 4, 533-539(1976). 15p. Dep. NTIS, PC A02/MF A01.

The most urgent concern of modern veterinary medicine is preservation of the health and vitality of useful farm animals to assure high production stability and productivity in industrial-scale animal production. Compared with traditional sheltering practices, the new production methods impose a changed environment on the animals and certain factors can influence the adaptability of the animals. The existing standards (limit values) for harmful gases such as ammonia (NH_3) and hydrogen sulfide (H_2S) in the environment are empirical values not scientifically based on exact tests for animal production. As for other climatic guide values, the notion of considering these harmful components of the stall air as independent factors rates as a particular drawback in veterinary medicine. Results are reported from studies on rats that aim to analyze the single and complex action of ammonia and hydrogen sulfide in the chronic animal test under optimal and suboptimal environmental temperatures.

9008 Investigation on measurement level of conductimetric sulfur dioxide analyzer. Oyake, T. *Hokkaido Kogai Boshi Kenkyusho Ho;* No. 1, 13-21(Mar 1975). (In Japanese).

Factors affecting the conductimetric measurement of sulfur dioxide were analyzed. Dust filter materials showed various SO_2 adsorption rates, ranging from 6.8 percent for a used Gelman A filter paper to 27.2 percent for a new Gelman A filter paper at an SO_2 concentration of 0.5 ppM. The rates of SO_2 adsorption on the gas inlet tube ranged from 3.2 percent for teflon to 8.6 percent for polyvinyl chloride to 15.6 percent for glass at the same SO_2 concentration. Nitric oxide, nitrogen dioxide, and hydrogen chloride at concentrations below 0.2 ppM and carbon monoxide below 40 ppM did not effect the measurement. Higher and lower flow rates were observed at temperatures lower and higher than 15°C, respectively, with that at 15°C as a standard. Loss of the solvent due to evaporation resulted in up to a 1.60 percent difference in measurement values.

9009 NOx damages: conditions and regulations. *Sangyo To Kankyo;* **3**: No. 9, 36-41(Sep 1974). (In Japanese).

Unlike sulfur oxides, nitrogen oxides concentrations in major Japanese cities increased from 1968 through 1972. Air Pollution Prevention Law article 23 section 1 states that an emergency is to be declared when hourly concentration of oxidants, as a secondary air pollutant, exceeds 0.15 ppM. The number of emergencies issued in 21 major cities and prefectures increased from 98 in 1971 to 328 in 1973. The total injuries reported from 1970 were 119,216. Of these, 53 percent were junior high school students, 25 percent were elementary school students. Damage to plants was greatest when oxidant concentration exceeded 0.15 ppM for more than 8 hr. A new environmental standard for NOx for Tokyo and Chiba was issued on May 8, 1973. It was aimed at reducing hourly NOx concentration for 24 hr to 0.02 ppM in 5 yr. New emission standards for major NOx-emitting equipment are given.

9010 (ORNL-tr—4470) **Effect of large quantities of fly-ashes produced by electric power plants on the hydro-physical properties of the soil and on the yields of some agricultural vegetable products.** Sedlackova, A.; Loebl, F. Translated by F.G. Stepanek from *Agrochemia;* **11**: 106-110(1971). 10p. Dep. NTIS, PC A02/MF A01.

The production of electric power plant fly-ashes in Czechoslovakia is approximately 6 to 8 million tons a year. The previously recommended application of 150 q/ha to 300 q/ha is absolutely insufficient for their complete and final removal from small power plants, let alone from the large ones. Larger quantities, because of their grain composition, could be utilized for the alteration of physical characteristics of heavy soils. However, it is necessary to consider the possible toxic effects of some chemical components of the fly-ashes on vegetable products. In our experiment with extremely heavy soil, the application of 8,000 q/ha and 20,000 q/ha resulted in a decrease of the weight by volume (Or) from 1.48 g/cm^3 to 1.35 g/cm^3 and to 1.04 g/cm^3, in a percentual increase in the number of non-capillary pores, and in alteration of the soil hydro-limits. The alteration of the soil physical characteristics, especially of the water retention properties, manifested itself in the yields of the experimental vegetable products: green feed mixture, sugar beets, barley and red clover. Beginning with the third year after the application of the fly-ashes, the yields of these products were higher than those grown on the control variant and on the variant with NPK nutrients alone. The decrease in yields of the first and second product were not as drastic in the field experiment as in the laboratory experiments. These, however, are only short-term results obtained with only one type of fly-ashes. Before a wider application of the fly-ashes in agriculture, an extensive study of all factors will be necessary.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 8996, 9075, 9076

9011 (HASL—328) **Health and Safety Laboratory environmental quarterly, June 1, 1977—September 1, 1977.** Hardy, E.P. Jr. (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Oct 1977. 179p. Dep. NTIS, PC A09/MF A01.

This report presents current information from the HASL environmental programs, the Australian Radiation Laboratory, the Air Resources Laboratories of NOAA, the Air Monitoring Section of the Bhabha Atomic Research Centre in Bombay, India and the National Radiation Laboratory in New Zealand. The initial section consists of interpretive reports and notes on background corrections for ^{90}Sr in ion-exchange resin used in the Australian fallout network, corrections to previously reported N_2O concentrations in the stratosphere, trace metal concentrations in a marine sediment as measured by five laboratories, an estimate of maximum credible atmospheric radioactivity concentrations from nuclear tests, strontium-90 concentrations in human bone in New York City and San Francisco through 1976, and worldwide deposition of ^{90}Sr through 1976. Subsequent sections include tabulations of radionuclide and stable lead concentrations in surface air; strontium-90 in deposition, milk, diet and tapwater; fallout and atmospheric radioactivity measurements in India and environmental radioactivity measurements in New Zealand. A bibliography of recent publications related to environmental studies is also presented.

9012 (HASL—328(APP.)) **Appendix to health and safety laboratory environmental quarterly.** (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Oct 1977. 205p. Dep. NTIS, PC A10/MF A01.

Tablulated data are presented on fallout ^{90}Sr deposition at world land sites; radionuclides on Pb in surface air; and ^{90}Sr content in samples of milk and drinking water.

9013 (HASL—329) **Health and Safety Laboratory environmental quarterly. Final tabulation of monthly ^{90}Sr fallout data: 1954—1976.** (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). 1 Oct 1977. 405p. Dep. NTIS, PC A18/MF A01.

This report presents the monthly ^{90}Sr deposition data derived from a global network of stations started in 1954. This program was carried out to assess the distribution patterns and inventory the amount of fallout of radionuclies from atmospheric nuclear tests. In 1976, monthly deposition rates had diminished to the point where measurable levels of ^{90}Sr were rarely observed.

REGULATIONS

REFER ALSO TO CITATION(S) 8566, 9009

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 9024

9014 **Subsurface probing by high-frequency measurements of the wave tilt of electromagnetic surface waves.** Lytle, R.J.; Lager, D.L.; Laine, E.F. (Univ. of California, Livermore). *IEEE Trans. Geosci. Electron.;* **GE-14**: No. 4, 244-249(Oct 1976).

An overview of the tilt of an electromagnetic surface wave propagating along the surface of the earth is given. High-frequency wave-tilt measurements can have important applications in low conductivity regions such as desert and permafrost areas. A specific application includes determining the depth of permafrost. Past applications of wave-tilt measurements were primarily with lower frequencies in regions with high ground conductivities. Thus low frequencies (less than 1 MHz) were needed to probe to significant depths. Wave-tilt calculations show that for low surface conductivities, it may be feasible to probe to significant depths using high frequencies (greater than 1 MHz). This enables resolution of thicknesses of layers, a result that has not been possible at low frequencies in the higher conductivity media. It is noted that differences in wave tilt occur for vertically and horizontally polarized surface waves. These wave-tilt differences are useful because they indicate profile characteristics that are sensitive in different ways to the two polarizations.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 8000, 8043, 8707, 9010

9015 (ORNL/EIS—112) **NSF-RANN trace contaminants abstracts for August 1977.** Ross, R.H. (ed.). (Oak Ridge National Lab., Tenn. (USA)). 30 Aug 1977. Contract W-7405-ENG-26. 30p. Dep. NTIS, PC A03/MF A01.

Abstracts are included for 49 publications during 1976 and 1977 on the toxic effects of trace amounts of environmental contaminants in animals, plants, and microorganisms.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 8048

9016 (BNWL—2127) **Multicomponent mass transport model: theory and numerical implementation (discrete-parcel-random-walk version).** Ahlstrom, S.W.; Foote, H.P.; Arnett, R.C.; Cole, C.R.; Serne, R.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). May 1977. Contract EY-76-C-06-1830. 128p. Dep. NTIS, PC A07/MF A01.

The Multicomponent Mass Transfer (MMT) Model is a generic computer code, currently in its third generation, that was developed to predict the movement of radiocontaminants in the saturated and unsaturated sediments of the Hanford Site. This model was designed to use the water movement patterns produced by the unsaturated and saturated flow models coupled with dispersion and soil-waste reaction submodels to predict contaminant transport. This report documents the theorical foundation and the numerical solution procedure of the current (third) generation of the MMT Model. The present model simulates mass transport processes using an analog referred to as the Discrete-Parcel-Random-Walk (DPRW) algorithm. The basic concepts of this solution technique are described and the advantages and disadvantages of the DPRW scheme are discussed in relation to more conventional numerical techniques such as the finite-difference and finite-element methods. Verification of the numerical algorithm is demonstrated by comparing model results with known closed-form solutions. A brief error and sensitivity analysis of the algorithm with respect to numerical parameters is also presented. A simulation of the tritium plume beneath the Hanford Site is included to illustrate the use of the model in a typical application. 32 figs.

9017 (ORNL—5171, pp 261-274) **Radiation measurements and assessments.** Haywood, F.F.; Cottrell, W.D.; Hubbard, H.M. Jr. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Methods are discussed that were developed to evaluate the characteristics of radiation fields in areas where selected segments in the nuclear fuel cycle or other energy-producing operations were carried out resulting in the possibility for exposure to the public. Inactive uranium mills were surveyed for radionuclides in tailings piles that might pose radiation hazards for human populations. The radiation doses from external exposure or from the inhalation or ingestion of ^{222}Rn, ^{230}Th, ^{226}Ra, and ^{226}Ra daughters in the mill tailings were estimated. Radiation monitoring surveys were also made at number of decommissioned ERDA sites. Gamma sources in soil and associated dose rates in surface air were measured at selected ORNL sites. Solid waste residues from oil shales were monitored for ^{226}Rn content to determine if any health hazards would result from the use of spent shales as fill material or in concrete products. Progress is reported for a study of ways to reduce the radiation exposure of personnel at light water reactors. It was concluded that the occupational exposure at operating LWR sites can be reduced by 10 to 20 percent.

SOIL

REFER ALSO TO CITATION(S) 8103, 8104, 8105

9018 (IAEA-R—1310-F) **Studies of migration and dispersion of radionuclides from the storage of radioactive wastes. Final report for the period 1 December 1972 - 29 February 1976.** Dlouhy, Z. (International Atomic Energy Agency, Vienna (Austria)). Aug 1976. 37p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Conditions were tested under which fixed low level liquid radioactive wastes could be safely stored in geological formations of Czechoslovakia. Geological models were constructed to yield relatively accurate information on the migration and dispersion properties of some soils and rock formation in both static and dynamic conditions. Based on results of the models further testing was conducted under field conditions. The principal radionuclides used during the tests were ^{90}Sr and ^{137}Cs. Relative transport and dispersion data are provided for various of the earth studied groups and an assessment of the various sites provided in the report.

9019 (LA-tr—77-51) **Concerning the existence of an unknown, natural α-activity in the 4.3—4.6 MeV range.** Meier, H.; Albrecht, W.; Boesche, D.; Hecker, W.; Menge, P.; Ruckdeschel, A.; Unger, E.; Zeitler, G.; Zimmerhackl, E. Translated from *Z. Naturforsch., a;* **25A**: 79-87(1970). 19p. Dep. NTIS, PC A02/MF A01.

Results obtained in the separation of platinum group ores, specifically osmiridium (iridosmine), are reported. The studies showed that in osmiridium samples of varying provenience, along with radionuclides of the natural decay chain (concentration < 1 ppM), an α-activity in the 4.3-4.6 MeV range and a γ-radiation at 200-220 KeV occurs. These activities cannot be assigned to any known radionuclides. The possible connection between the enriched activity from osmiridium and the analogous α-activity in the 4.3-4.6 MeV range for various working groups in ores and minerals (molybdenite, etc.) is discussed. Geochemical effects are also discussed (excess ^{235}U, ^{235}Pu contents of geological samples, etc.) whose probable connection to the 4.3-4.6 MeV α-radiation indicates the existence of natural transuranium isotopes with an atomic number $Z > 96$. The question of a connection between the activity found in the fractions containing the platinum series metals and the superheavy elements of the platinum metal group which may be present in nature is also discussed.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 9011, 9012, 9013

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 7882, 7885, 7886, 7887, 7915, 8561

9020 (PB—268028) **Balancing national energy needs with ecological requirements, eastern energy and land use task force report, executive summary.** Quinn, H.B. (Fish and Wildlife Service, Washington, D.C. (USA). Office of Biological Services). 15 Apr 1977. 38p. (FWS/OBS—77/23). NTIS PC A03/MF A01.

This report discusses anticipated energy and mineral developments in the Eastern United States, emphasizing the interplay with fish, wildlife and their habitat; key problems or issues from such developments; and, recommendations for active participation in effecting viable solutions.

9021 (PB—268478) **Reclamation and revegetation of strip mined land: a selected bibliography of publications in University of Minnesota Forestry Library. appendix: a selected bibliography on the environmental effects of copper-nickel mining in Minnesota. Bibliography series.** Albrecht, J.; Smith, D. (Minnesota Univ., St. Paul (USA)). 1976. 24p. NTIS PC A02/MF A01.

Reclamation and revegetation of strip mined land and the effect on the environment resulting from strip mining are topics frequently researched by College of Forestry students, but these subjects are not thoroughly covered by available indexes. The authors determined that a bibliography of materials in the Forestry Library collection would be a helpful starting point for students' research. This bibliography is arranged alphabetically by author. Only English language literature has been included. There was no attempt to limit the inclusion of references because of date. The oldest reference included is from 1923; the most recent from 1976. A supplemental bibliography on the environmental effects of copper-nickel mining in Minnesota is appended.

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

9022 **Comparison of model and observed currents in Lake Michigan.** Allender, J.H. (Energy and Environmental Systems Division, Argonne National Laboratory, Argonne, Ill. 60439). *J. Phys. Oceanogr.;* **7**: No. 5, 711-718(Sep 1977).

Results from four deterministic numerical-hydrodynamical models for Lake Michigan are compared to data from the field program of the Federal Water Pollution Control Agency (FWPCA) for September 1963, and to other limited data from which lake currents can be inferred. Fourier norms and average angle statistics show that model and observed currents at fixed locations do not compare well. Comparability does not improve when near-inertial motions are removed or when motions having periods up to 72 h are removed. This lack of agreement is practically unavoidable and results primarily from inadequate knowledge of the wind field and probably from the grid scale used in the models. Qualitative agreement between the model and FWPCA currents is seen in lakewide plots of several-day average motion. Surface currents inferred from satellite imagery are grossly similar to model currents under the appropriate, average wind conditions.

9023 **Biogenic meromixis and stability in a soft-water lake.** Culver, D.A. (Univ. of Washington, Seattle). *Limnol. Oceanogr.;* **22**: No. 4, 667-686(Jul 1977).

Hall Lake, Washington, was studied during a period of meromixis (1950 to 1953) and during a period of holomixis (1968 to 1972). Comparisons of thermal cycles, light penetration, chemical distribution, and productivity indicate that the lake had a greater productivity while meromictic, even though the seasonal accumulation of dissolved materials in the deep waters was greater during the holomictic period. Calculations showed that the stability due to chemical stratification was actually greater during the holomictic period, supporting the idea that in biogenic meromictic lakes circulation may be controlled more by thermal phenomena than by chemical stratification. Turbid inflows during winter tended to destroy meromixis, but low transparencies due to algal blooms in summer tended to encourage it and may be the primary way by which biogenic meromictic lakes become permanently stratified.

9024 **Use of 114 In-EDTA tracer for identification of water in mines.** Lebecka, J. *Przegl. Gorn.;* **32**: No. 12, 551-554(Dec 1976). (In Polish).

A new tracer for investigating the movement of underground or surface waters has been developed. It is a complex compound In-EDTA which is traced by the isotope In-114. A sensitive method of measurement has also been developed, which allows the results to be obtained very rapidly. The detectability of the radioactive isotope is so high that the use of the tracer presents no problems for radiation protection.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 7998, 8000, 8001, 8003, 8004, 8043, 8279, 8999, 9000, 9011, 9015, 9033, 9096, 9098, 9101, 9108

9025 (PB—267630) **National interim primary drinking water regulations.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Water Supply). 1976. 163p. (EPA—570/9/76/003). NTIS PC A08/MF A01.

The National Interim Primary Drinking Water Regulations published herein were promulgated on December 24, 1975, in accordance with the provisions of the Safe Drinking Water Act (Public Law 93-523). Additional Interim Primary Regulations for radioactivity in drinking water were promulgated on July 9, 1976. These regulations become effective on June 24, 1977, and become in essence the standards by which all public drinking water supplies are judged.

9026 (PB—268237) **Selective withdrawal and heated water discharge: influence on the water quality of lakes and reservoirs. Part I. Selective withdrawal. Technical report.** Monkmeyer, P.L.; Hoopes, J.A.; Ho, J.C.; Clark, G.R. (Wisconsin Univ., Madison (USA). Water Resources Center). 1977. Contracts DI-14-31-0001-3550;DI-14-31-0001-3850. 76p. (WIS-WRC—77-03). NTIS PC A05/MF A01.

A variety of methods have been proposed to improve the water quality of lakes and reservoirs. This work is directed toward the overall improvement of water quality in a reservoir through the removal of the poor quality, hypolimnetic water. In particular, theoretical and experimental investigations on selective withdrawal of a viscous, non-diffusive, linearly-stratified fluid from the bottom and intermediate depths of a reservoir have been carried out. The governing differential equations which describe planar and axisymmetric withdrawal are derived. In the case of bottom withdrawal a momentum integral technique that retains inertial effects is employed. Theoretical horizontal velocity profiles are obtained together with expressions for the thickness of the layer of hypolimnetic water withdrawn. Expressions are also derived in each case to predict the quality of the water withdrawn. Laboratory experiments are described; the results obtained verify the theoretical predictions reasonably well. Procedures for predicting the withdrawal layer thickness and discharged water quality in an actual reservoir are discussed.

9027 (PB—268563) **Environmental assessment sampling and analysis: phased approach and techniques for level 1. Phase report, Apr 1976—Apr 1977.** Dorsey, J.A.; Johnson, L.D.; Statnick, R.M.; Lochmuller, C.H. (Environmental Protection Agency, Research Triangle Park, N.C. (USA). Industrial Environmental Research Lab.). Jun 1977. 40p. (EPA—600/2-77/115). NTIS PC A03/MF A01.

The report discusses a three-level approach to sampling and analysis, and gives details of a Level 1 sampling and analysis phased approach for an environmental source assessment. A research program was initiated to develop a sampling and analytical approach for conducting environmental source assessments of the feed, product, and waste streams associated with industrial and energy processes. An environmental source assessment identifies potential air, water, and terrestrial problems for both regulated (specific standards exist) and unregulated pollutants (future regulations may be necessary). The three-level sampling and analysis approach resulted from this program. Level 1 is a complete survey of all streams, using simplified, generalized sampling and analytical methods which permit priority ranking; i.e., hazardous streams are distinguished from those less hazardous or relatively innocuous in nature. Level 2 is detailed sampling and analysis of the streams ranked in the highest priority by the Level 1 survey. Other streams may then be addressed according to potential hazard. Level 3 involves continuous monitoring of 'key' indicator materials to evaluate the effect on emissions of process variability.

9028 (UCRL—79867) **Ground-water quality effects of an underground coal gasification experiment.** Mead, S.W.; Campbell, J.H.; Stephens, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1977. Contract W-7405-ENG-48. 15p. (CONF-770652—8). Dep. NTIS, PC A02/MF A01.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, California, United States of America (USA) (6 Jun 1977).

Ground-water sampling and analysis have been carried out at the site of an in situ coal gasification experiment conducted by the Lawrence Livermore Laboratory (LLL) near Gillette, Wyoming. An important environmental question associated with the in situ gasification of coal concerns the possibility that reaction products

(ash and tars) left underground following the gasification process may lead to the contamination of local ground waters. In an effort to clarify the significance of this problem, the water from more than 12 wells in the vicinity of an underground gasification experiment before, during, and up to 6 months following gasification was sampled. Water samples were analyzed in the field and at LLL, U.S. Geological Survey, and Research Triangle Institute for a variety of characteristics, including the presence of 70 inorganic elements and compounds, phenolic materials, dissolved organic carbon, and volatile organics. A greatly increased concentration of phenolic materials (450 mg/l) just outside the burn boundary, and a variety of inorganic species issuing from within the residual ash bed were found. All contaminants decrease rapidly with distance, although above-background levels of some species were detected 100 ft from the burn zone. Several important contaminants showed a large decrease in concentration with time, possibly a result of adsorption.

9029 Laboratory studies on the effect of metals on oxygen uptake by sewage sludge in brackish water. Sylvester, A.J.; Ware, G.C. (Univ. of Bristol, Eng.). *Mar. Pollut. Bull.;* 8: No. 2, 45-47(Feb 1977).

Heavy metals are often regarded as toxic to all forms of life and therefore generally undesirable. However, their presence in industrial wastes dumped into the Bristol Channel stimulates the growth of certain bacteria in the water and may therefore hasten the self purification process and not be wholly undesirable in moderation.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9075, 9076

9030 (CONF-770409—10) **Plutonium in Baltic sediments.** Simola, K.; Jaakkola, T.; Miettinen, J.K.; Voipio, A.; Niemistoe, L. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 1977. Contract EY-76-C-02-3011. 4p. Dep. NTIS, PC A02/MF A01.

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

Marine sediments accumulate the bulk of plutonium produced by nuclear tests. The nuclear power industry will form an additional source of plutonium, and it is important to determine the present background levels of plutonium in sediments and to compare the accumulation rate in the Baltic with that in other areas of the world. Plutonium was determined on four sediment cores collected from the Baltic Sea in 1974 and 1975. Two of the samples were from oxygenated coastal sediment with benthic life and two cores were collected from deep basins in the Baltic at depths of 183 m and 164 m where the bottoms were anoxic, with no benthic life, and where the rate of sedimentation is rather high. Data are presented on the Pu-239,240 content of the sediment cores as is pCi/kg dry wt in the different core sections. The highest plutonium concentrations were found near the surface, at depths of 0 to 8 cm. In all cores the plutonium concentration decreases sharply at a depth of about 6 to 8 cm.

9031 ^{65}Zn specific activities in the migratory Pacific hake Merluccius productus. Cutshall, N.H.; Naidu, J.R.; Pearcy, W.G. (Oregon State Univ., Corvallis). *Mar. Biol.;* 40: No. 1, 75-80(25 Feb 1977).

Pacific hake [Merluccius productus (Ayres)], migrating northward along the California coastline during summer, encounter the southwesterly flowing plume of the Columbia River. Radioactive ^{65}Zn associated with the plume waters is taken up by the migrating hake. Smaller fish reflect this contamination earlier than larger fish. Zinc 65 specific activities increase toward the north as far as 46°N, off the mouth of the Columbia River, and then decline northward along the coast of Washington.

WATER

9032 (WaBoLu—32/76) **Radioactive substances in waste waters due to the use of radionuclides. Report on a statistic from Berlin (West).** Aurand, K.; Gans, I.; Ruehle, H.; Wolter, R. (Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene). Jan 1976. 19p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

It has been found that the relative amounts of radionuclides and also, approximatively, the activities of the waste water may be determined by asking the user of unsealed radioactive substances to supply written information. At the moment, the most important radionuclide from the point of view of radiation protection is ^{131}I. The acitivities of this isotope in waste waters may be a finite contribution to the hypothetical radiation exposure of the population (thyroid dose). For an assessment of the actual radiation exposure, however, further measurements of the ^{131}I concentration in the effluents from sewage treatment plants or in the drainage ditches themselves would be required.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9026

9033 (PB—267608) **Thermometry in the control of water quality. Final report.** Wood, S.D. (National Bureau of Standards, Washington, D.C. (USA)). May 1977. 22p. (NBSIR—77-1227). NTIS PC A02/MF A01.

A limited study of thermometry in water pollution was made which focused on water analysis, thermal pollution, and the work of standards committees. It was concluded that the current needs in this field can be addressed most efficiently by the National Bureau of Standards with educational and calibration activities. Suggestions are made concerning possible contributions by NBS with an emphasis on those activities having large impacts for small investments of NBS resources.

9034 (PB—268897) **Density and distribution of benthos in Lake Keowee, South Carolina. Doctoral thesis.** Ryals, G.L. Jr. (Clemson Univ., S.C. (USA). Water Resources Research Inst.). Dec 1975. 89p. NTIS PC A05/MF A01.

Density and distribution of benthic macroinvertebrates were studied from August 1971, to August 1973, in Lake Keowee, a large newly formed impoundment in northwestern South Carolina scheduled to receive discharges of heated water. The effects of depth, station location, and season on density and taxonomic composition of benthos were examined. Total numbers of benthos varied inversely with depth. Abundance was affected by location of sampling sites within the lake, being lower in the discharge canal and proximal areas than in the intake canal and control areas. Station differences were probably related to variations in the particle size distribution and organic content of the substrate. The differences among substrates resulted from pre-impoundment construction activities in the discharge area. Total density generally had 3 peaks, in the spring, summer, and autumn. Temperature, dissolved oxygen, and other water quality parameters did not vary significantly among the stations.

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

9035 (ORNL—5171, pp 295-297) **Public health and demographic statistics.** Patrick, C.H.; Loebl, A.S.; Miller, F.L.; Ritchey, P.N. Jr. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The purpose of this program is to assess the methodology and available data sources appropriate for use in analytical studies and environmental impact statements concerning the health effects of nuclear power plants. The techniques developed should be applicable as well to evaluation of the known risks of high levels of radiation exposure and of conflicting evidence on low-level effects, such as those associated with the normal operations of nuclear power plants. To accomplish this purpose, a two-pronged approach has been developed. The first involves a determination of the public health and demographic data sources of local, state, and federal origin that are available for use in analyses of health effects and environmental impact statements. The second part involves assessment of the methods used by epidemiologists, biostatisticians, and other scientists as found in the literature on health effects. This two-pronged approach provides a means of assessing the strength and shortcomings of studies of the impact of nuclear facilities on the health of the general population in a given locality.

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 8556, 8557

ENVIRONMENTAL IMPACT STATEMENTS

9036 (ORNL—5171, pp 91-93) **Generic environmental statement on the routine use of plutonium-powered cardiac pacemakers.** Shoup, R.L.; Robinson, T.W.; O'Donnell, F.R. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The purpose of a continuing program at ORNL is to provide technical assistance to the NRC on writing and editing of the final environmental statement on the routine use of nuclear-powered (primarily ^{238}Pu) cardiac pacemakers. This environmental statement defines the safety and reliability standards that nuclear-powered pacemakers are required to meet. All aspects of the risks to the patients, the public, and the environment are evaluated both for the routine use of plutonium-powered pacemakers and for postulated accidents involving pacemaker patients. Benefits derived from the use of plutonium-powered units are discussed and weighed against the risks in order to determine whether routine use is justified. Available alternative pacemakers with various performance characteristics are compared with respect to costs and to the needs of pacemaker patients.

BIOMEDICAL SCIENCES, BASIC STUDIES

9037 (COO—3139-29) **Proteins in growth regulation during early development. Progress report, 1976—1977.** Klein, N.W. (Connecticut Univ., Storrs (USA). Dept. of Animal Genetics). Aug 1977. Contract EY-76-S-02-3139. 22p. Dep. NTIS, PC A02/MF A01.

Studies were conducted to determine mechanisms regulating the synthesis of serum proteins by the yolk-sac and to determine if serum proteins are developmental signals. Synthesis of serum proteins in the yolk-sac and liver was determined at various stages of development and effects of teratogenic agents and genetic mutations on protein synthesis were studied. The regulation of serum protein synthesis was studied in cell cultures and in cell-free protein synthesizing systems derived from the yolk-sac. Studies were also conducted on effects of serum proteins on rat embryos, chick embryos without yolk-sacs, and isolated brains. (HLW)

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 8005

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 9037, 9052, 9055, 9060, 9111

9038 (CONF-770860—1) **Heterogeneity of human alpha-fetoprotein (HAFP) as revealed by agarose gel electrophoresis and isoelectric focusing in urea-acrylamide gels.** Lester, E.P.; Miller, J.B.; Yachnin, S. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1977. Contract EY-76-C-02-0069. 20p. Dep. NTIS, PC A02/MF A01.

From 5. meeting of the international research group for carcino embryonic proteins; Copenhagen, Denmark (6 Aug 1977).

HAFP was purified from five patients with hepatoma, one with gastric cancer, and one with an embryonal cell tumor, as well as from fetal liver and a monkey tumor cell line grown in tissue culture. The pattern of microheterogeneity of purified HAFP was defined for each HAFP isolate, and was demonstrated to be present in native sera, using crossed immunoelectrophoresis in agarose gels and isoelectric focusing in polyacrylamide gels containing 8 M urea. Three, and in one case four, species were seen in agarose, and were further resolved to reveal 6 major species with isoelectric focusing which could be correlated with the agarose gel variants. We have demonstrated a relationship between the immunosuppressive potency of certain HAFP preparations and the proportion of specific HAFP isomers which they contain as shown by these techniques. We have desialylated each of our preparations and demonstrated that this does not alter immunosuppressive potency but leaves residual complex microheterogeneity. Desialylated HAFP isolates contain six major HAFP isomers by isoelectric focusing, indicating that HAFP heterogeneity is based upon multiple charge differences in the HAFP molecule, apart from sialic acid content. The nature of these charge differences remain to be determined. We postulate that these charge differences modulate the immunosuppressive potency of HAFP.

9039 (CONF-770860—2) **Inhibition of human lymphocyte transformation by human α-fetoprotein (HAFP): studies on the mode of HAFP action and the role of HAFP polymorphism.** Lester, E.P.; Miller, J.B.; Yachnin, S. (Chicago Univ., Ill. (USA). Dept. of Medicine; Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1977. Contract EY-76-C-02-0069. 22p. Dep. NTIS, PC A02/MF A01.

From 5. meeting of the international research group for carcino embryonic proteins; Copenhagen, Denmark (6 Aug 1977).

To explain the mechanism of inhibition of human lymphocyte transformation by human alpha-fetoprotein (HAFP), we sought for, and failed to find, evidence of physical association between HAFP and phytomitogens or antihuman thymocyte antiserum. In addition, 20 to 40 fold increases in mitogen dose do not reverse the inhibition of lymphocyte transformation by a constant dose of HAFP. The presence of HAFP does not interfere with the attachment of ^{125}I-labeled phytohemagglutinin to the lymphocyte surface. Two-dimensional crossed immunoelectrophoresis of HAFP isolated from the body fluids of hepatoma patients demonstrates three charged species of HAFP designated as HAFP-1 (the most cathodal), HAFP-2, and HAFP-3 (the most anodal). The potency of HAFP isolates in inhibiting lymphocyte transformation can be positively correlated with the ratio HAFP-3 : HAFP-1 in each preparation. Passage of HAFP isolates over CM-cellulose allows the isolation of two HAFP fractions, one at pH 4.95, and the other at pH 5.24. The pH 4.95 CM-cellulose isolate is enriched in the more electronegative HAFP species (HAFP-3) and is, on the average, two times more potent than the pH 5.24 CM-cellulose HAFP isolate. The latter, by comparison with native HAFP, is enriched in the more electropositive HAFP species (HAFP-1). The CM-cellulose HAFP isolates are identical in sialic acid content.

9040 **Altered absorption spectra of iso-1-cytochromes c from mutants of yeast.** Schweingruber, M.E.; Sherman, F.; Stewart, J.W. (Univ. of Rochester, NY). *J. Biol. Chem.;* **252**: No. 19, 6577-6580(10 Oct 1977).

Low temperature (-190°) spectrophotometric recordings were made of mutant strains of the yeast Saccharomyces cerevisiae containing various altered sequences of iso-1-cytochromes c. All mutants with replacements of the tryptophan 64 residue had abnormal C/sub α/-bands, in which the α_2-peaks were accentuated to various degrees by being more separated from the major α_1-peaks and by making up a larger portion of the total C/sub α/-peak. The altered iso-1-cytochromes c included those having the normal tryptophan 64 replaced by phenylalanine, leucine, tyrosine, cysteine, serine, or glycine as well as those having replacements at position 64 and additional replacements at other sites. Tryptophan 64 in iso-1-cytochrome c, which corresponds to tryptophan 59 in vertebrate cytochromes c, appears to be an important residue for preserving the electronic environment of the heme group. It is uncertain, however, whether altered spectra are due specifically to the abnormal residues at position 64 or due to distorted tertiary structures caused by the replacements.

9041 **Self-association of apolipoprotein A-II from plasma high density lipoproteins of rhesus monkey (Macaca mulatta).** Barbeau, D.L.; Teng, T.L.; Scanu, A.M. (Univ. of Chicago). *J. Biol. Chem.;* **252**: No. 19, 6745-6749(10 Oct 1977).

The sedimentation equilibrium behavior of apolipoprotein A-II (apo-A-II) obtained from plasma high density lipoproteins (HDL) of the rhesus monkey (Macaca mulatta) was studied in aqueous solutions of 0.02 M EDTA, pH 8.6, at 20°. The ultracentrifugal analyses which were carried out at several initial protein concentrations and rotor speeds generated curvilinear plots of molecular weight versus concentration; the curves had overlapping segments, indicating that apo-A-II undergoes a reversible self-association. This process could best be described as either a monomer-dimer-tetramer equilibrium having association constants of $K_2 = 3.24 \times 10^3 M^{-1}$, $K_4 = 1.46 \times 10^{11} M^{-3}$, or as a monomer-dimer-trimer-tetramer equilibrium having association constants of $K_2 = 3.04 \times 10^3 M^{-1}$, $K_3 = 3.49 \times 10^6 M^{-2}$, and $K_4 = 1.33 \times 10^{11} M^{-3}$. The results did not permit a clear choice between the two possibilities, although the former model was favored. The self-associating property of rhesus apo-A-II (single chain) determined in this study is comparable qualitatively to that reported for human apo-A-II (two identical chains linked by a disulfide bridge), but differs significantly from that of apo-A-II after reduction and carboxymethylation. However, this difference may be attributable to the fact that the two proteins were not studied under the same concentration ranges.

9042 **RNA-dependent DNA polymerase of avian sarcoma virus B77. Binding of viral and nonviral ribonucleic acids to the α, β_2, and $\alpha\beta$ forms of the enzyme.** Hizi, A.; Leis, J.P.; Joklik, W.K. (Duke Univ., Durham, NC). *J. Biol. Chem.;* **252**: No. 19, 6878-6884(10 Oct 1977).

The extent of binding of various RNA species to the three forms of avian sarcoma virus B77 RNA-dependent DNA polymerase was determined using a sensitive nitrocellulose filter binding technique which was capable of detecting binding reactions with association constants as low as 3×10^6 liters x mole^{-1}. All three enzyme forms, $\alpha\beta$, β_2, and α, bound to all single-stranded RNA species that were tested, including nonviral RNAs. 70 S viral RNA exhibited the highest association constant (about 10^{11} liters x mole^{-1}), and a population of virus-derived tRNA molecules from which tRNA/sup Trp/ had been removed, the lowest (about 3000 times lower). The affinity for other RNAs was roughly proportional to their size. The affinity of RNAs for the $\alpha\beta$ enzyme form always exceeded that for the two others by a factor that depended on the particular RNA,

never exceeded 6 and was sometimes as low as 1.2. The association constant of the $\alpha\beta$ enzyme form with viral 70 S RNA was about 15-fold higher than that with viral 35 S RNA. 35 S RNA annealed to tRNA/sup Trp/ had an association constant that was only 2.5 times higher than that of 35 S RNA alone. This finding suggests that the tertiary structure of 70 S RNA plays a significant role in its affinity for B77 DNA polymerase.

9043 Isolation and properties of the vaccinia virus DNA-dependent RNA polymerase. Nevins, J.R.; Joklik, W.K. (Duke Univ., Durham, NC). *J. Biol. Chem.;* **252**: No. 19, 6930-6938(10 Oct 1977).

A vaccinia virus-specified DNA-dependent RNA polymerase was isolated from the cytoplasm of infected HeLa cells. The enzyme appeared in cells only after infection; it differed in its chromatographic properties from all cellular RNA polymerases; and its subunit composition (seven subunits ranging in size from 13,500 to 135,000 daltons) was completely different from that of HeLa cell RNA polymerases I and II. The latter two enzymes were also isolated and their subunit compositions were found to resemble closely those of mouse plasmacytoma MOPC 315 RNA polymerases I and II. The three largest subunits of the isolated vaccinia virus-specified RNA polymerase migrated in sodium dodecyl sulfate-polyacrylamide gels at the same rate as virion core polypeptides VP1c, VP1d, and VP2c; the enzyme may therefore be the same as the vaccinia virus core-associated RNA polymerase. The purified enzyme was free of detectable exonuclease and poly(A) polymerase activity. It was maximally stimulated by 0.08 M KCl and 0.001 M MN^{2+}; Mg^{2+} could not substitute for MN^{2+} to a significant degree. The enzyme was very resistant to α-amanitin. It was 10 times more active with denatured calf thymus or vaccinia virus DNA as template than with the corresponding native DNAs, but transcribed the synthetic double-stranded poly[d(A-T)] almost as rapidly as single-stranded natural DNA. It transcribed all sequences of native vaccinia virus DNA.

9044 Isolation and partial characterization of the poly(A) polymerases from HeLa cells infected with vaccinia virus. Nevins, J.R.; Joklik, W.K. (Duke Univ., Durham, NC). *J. Biol. Chem.;* **252**: No. 19, 6939-6947(10 Oct 1977).

Three poly(A) polymerases were isolated from HeLa cells infected with vaccinia virus. Two were cellular enzymes. The first was a poly(A) polymerase that was located primarily in the nucleus, comprised a single polypeptide with a M/sub r/ = 50,000, was stimulated by Mn^{2+} and also by Mg^{2+}, and was able to use RNA, but not oligo(A), as primer. The second, which accounted for about 75 percent of the total cellular poly(A) polymerase activity, was located primarily in the cytoplasm, consisted of a single polypeptide with a M/sub r/ approximately equal to 75,000, was absolutely dependent on the presence of Mn^{2+}, and was able to use both RNA and oligo(A) as primer. The third enzyme was present only in cells infected with vaccinia virus. It was a heterodimer composed of two polypeptides with M/sub r/ = 57,000 and 37,000, was stimulated by Mn^{2+} and also by Mg^{2+}, and was able to use both RNA and oligo(A) as primer. It was identical in all properties tested with the poly(A) polymerase that can be isolated from vaccinia virus cores except for somewhat different chromatographic properties, caused possibly by a charge difference. The subunits of this vaccinia virus-specified poly(A) polymerase were different not only from those of either of the two host cell poly(A) polymerases, but also from those of the vaccinia virus-specified DNA-dependent RNA polymerase; it is therefore a distinct virus-specified enzyme. No other virus-specified poly(A) polymerase was present in infected cells.

9045 Gibberellic-acid-induced synthesis and release of cell-wall-degrading endoxylanase by isolated aleurone layers of barley. Dashek, W.V.; Chrispeels, M.J. (Univ. of California, San Diego, La Jolla). *Planta;* **134**: No. 3, 251-256(1977).

When aleurone layers of barley (Hordeum vulgare L.) are incubated with gibberellic acid (GA_3), xylose and arabinose, both as free sugars and bound to larger molecules, are released into the medium. Release begins 10 to 12 h after the start of incubation and continues for at least 60 h. At the same time there is a GA_3-induced breakdown of the cell wall resulting in a loss of $^2/_3$ of the cell-wall pentose during 60 h of incubation. GA_3 causes the appearance in the medium of an enzyme (or enzymes) which hydrolyze larchwood xylan and aleurone-layer arabinoxylan. Release of the enzyme(s) into the medium begins 28 to 32 h after the start of incubation. Enzyme activity does not accumulate to any large extent in the tissue prior to release into the medium, and is present in very low levels only in the absence of GA_3. Xylanase activity is associated with a protein (or proteins) with a molecular weight of 29,000. The hydrolysis of the xylans is largely caused by endoxylanase activity, indicating the importance of endoglycosidases in the GA_3-induced breakdown of the aleurone cell wall.

9046 Ultracentrifugal behavior of apolipoprotein A-I of rhesus monkey (Macaca mulatta). Barbeau, D.L.; Scanu, A.M. (Univ. of Chicago). *J. Biol. Chem.;* **251**: No. 23, 7437-7441(1976).

The sedimentation equilibrium and sedimentation velocity of apolipoprotein A-I (apo-A-I) from high density lipoproteins of rhesus monkey plasma were studied in aqueous solutions of 0.02 m EDTA, pH 8.6, as a function of protein concentration. The sedimentation equilibrium results showed that, in the concentration range between 9 and 36 μm (0.25 to 1.0 g/liter), apo-A-I behaved as a single species of molecular weight 28,200. An analysis of the data generated nonlinear, nonoverlapping molecular weight versus concentration plots pointing at the existence of a heterogeneous population of apo-A-I. By sedimentation velocity studies apo-A-I at concentrations between 68 and 330 μm exhibited two distinct components, with s/sub 20,w//sup 0/ = 1.9 and s/sub 20,w//sup 0/ = 3.9. These two components had an identical amino acid composition and retained similar s/sub 20,w/ values as before column fractionation. The slow component had a diffusion coefficient of 8.27×10^{-7} cm^2/s and, assessed by the criteria of sedimentation equilibrium ultracentrifugation, remained monomeric even at concentrations of 125 μm. The fast component behaved as a self-associating system. The equilibrium constant for this association was found to be 9.5×10^{23} m^{-5}. Thus, rhesus apo-A-I, dissolved in 0.02 m EDTA, pH 8.6, consisted of two distinct species, one monomeric over a relatively wide range of concentrations, the other readily self-associating. Their structural relationship remains to be established. This ultracentrifugal behavior of rhesus apo-A-I differs markedly from that reported for human apo-A-I.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 9057

CYTOLOGY

9047 (COO—4159-01) **Genetically programmed abnormalities of cell interactions.** Bennett, D. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). 1977. Contract EE-77-S-02-4159. 18p. (CONF-770239—1). Dep. NTIS, PC A02/MF A01.

From The molecular basis of cell-cell interaction (symposium); San Diego, California, USA (14 Feb 1977).

Taken as a whole, the effects of the T/t locus mutations on the functional, morphological, and serological properties of embryonic and spermatogenic cells justify interpretations that the cell membrane is involved. At present no judgment can be made as to whether the abnormalities seen are primary effects of the mutant genes, or secondary to some other, as yet unknown defects. Nevertheless, these mutants offer the opportunity to characterize and identify membrane molecules lying at the cell surface and mediating intercellular interactions, but also molecules at the inner face of the membrane that may be important in transducing or implementing information coming from the outside.

9048 Volumes and cellularity in populations of hematopoietic clones. Reincke, U.; Cronkite, E.P.; Hinkelmann, K. *Nouv. Rev. Fr. Hematol.;* **16**: No. 2, 255-272(1976).

Volumes of hematopoietic spleen colonies were estimated by measuring parameters of superimposed triaxial ellipsoids. Observations were made on groups of colonies that contained only undifferentiated cells or had differentiated to varying degrees into purely erythropoietic, purely granulocytic or purely megakaryocytic colonies. The average volume occupied by one cell and surrounding matrix, the so-called single cell space, was determined for each type of colony. The estimated colony cellularity was then computed from the measured colony volume and the tabulated single cell space. The techniques of measurement are described. Formulas are provided to estimate mean and variance of volumes and their cell contents. Data on the distribution of spleen colony size and cellularity after seven days of growth are given.

GENETICS

REFER ALSO TO CITATION(S) 9047

9049 Isolation of cadmium- and mercury-sensitive mutants of Escherichia coli and some factors influencing their sensitivities. Ohta, T.; Udaka, S. (Nagoya Univ., Japan). *Agric. Biol. Chem. (Tokyo);* **41**: No. 3, 461-466(Mar 1977).

Several Cd^{2+} hypersensitive and Hg^{2+} sensitive mutants of Escherichia coli K-12 were isolated after repeated mutagenesis with nitrosoguanidine. The Cd-hypersensitive mutant, CD17P, could not grow in a chemically defined liquid medium containing 0.5 μM Cd^{2+}, and the growth of Hg-sensitive mutant, HG17P-52, was inhibited by 0.9 μM Hg^{2+}. Thus, CD17P and HG17P-52 were respectively about 1000 fold and 4 fold more sensitive than the parental strain. Both mutants were also considerably more sensitive to Zn^{2+} than their parent, but they did not show any appreciable change in sensitivity to other metals tested. Among the various metabolites and chemicals tested, reducing agents such as cysteine, dithiothreitol and vitamin C showed a protective effect against metal toxicity. Reduced

glutathione was effective only against Hg^{2+}. EDTA specifically and efficiently reversed only Cd^{2+} toxicity.

9050 DNA quantity, satellite DNA and karyotypic variations in kangaroo rats (Genus dipodomys). Hatch, F.T. (Univ. of California, Livermore); Bodner, A.J.; Mazrimas, J.A.; Moore, D.H. II. *Chromosoma;* **58**: 155-168(1976).

The genus Dipodomys (kangaroo rats) exhibits major interspecies variations in the proportions of highly reiterated satellite DNA sequences in the genome as well as in the chromosome number and the proportions of uni-armed and bi-armed chromosomes. For nearly all of the approximately 22 species of the genus and several subspecies, liver DNA was distributed in neutral CsCl buoyant density gradients into four fractions; principal DNA (1.698 g/ml), intermediate-density DNA (1.702 g/ml), MS satellite (1.707 g/ml) and HS (heavy) satellites (1.713 g/ml). The total nuclear DNA content of diploid liver cells measured in eleven species by quantitative cytophotometry, ranged from 6.9 to 10.9 pg. These data were correlated with known features of the karyotypes of individual species. The salient findings were: (1) that interspecies variations in diploid chromosome number cluster at 52-54, 60-64 and 70-72 (2) that high total nuclear DNA was associated with high chromosome number, and with relatively large amounts of satellite DNA (3) that a high ratio of HS satellites to intermediate-density DNA was generally correlated with a predominance of metacentric and submetacentric chromosomes (high fundamental number). The relationships of satellite DNA to karyotype structure reveal a new level of hierarchy in the genome that appears capable of exerting global control over environmental adaptation and the evolution of new species. This mechanism is consistent with recent hypotheses that changes in the macro-structure of the genome are more important than point mutations in facilitating the rapid phases of animal evolution.

METABOLISM

REFER ALSO TO CITATION(S) 9079, 9110, 9116

9051 (COO—1495-29) **Movement of metal cations through the soil to the plant root membrane. Technical progress report, September 1, 1976—November 30, 1977.** Barber, S.A.; Baligar, V.C. (Purdue Univ., Lafayette, Ind. (USA)). Aug 1977. Contract EY-76-S-02-1495. 40p. Dep. NTIS, PC A03/MF A01.

This project investigates the mechanisms governing metal cation flux to plant roots growing in soil. The K/Rb ratio of uptake by plants was used to evaluate sources supplying cations to the root. In solution culture, corn and onions absorbed K and Rb interchangeably. Equilibrium studies on four mineral soils and four organic soils indicated Rb was adsorbed preferentially on exchange sites so that the K/Rb in solution was larger than the K/Rb ratio on the exchange sites. On mineral soils the preference for Rb increased from 1.9 to 4.4 as exchangeable K decreased. Corn grown on the mineral soils had a K/Rb ratio of uptake similar to that on the exchange sites. Onions grown on the same soils had a K/Rb ratio of uptake similar to that in the soil solution. These differences are being used to determine mechanisms governing the cation flux. Root temperature affected K uptake parameters of corn roots and soil temperature affected K diffusion rates and K levels in soil solution. The effect on K uptake of temperature induced changes in individual parameters were evaluated in the simulation model. Uptake of K was simulated for all plant growth experiments and compared with observed K uptake to aid in development of the mathematical model.

9052 (COO—3139-30) **Proteins in growth regulation during early development. Comprehensive three year report, 1974—1977.** Klein, N.W. (Connecticut Univ., Storrs (USA). Dept. of Animal Genetics). Aug 1977. Contract EY-76-S-02-3139. 67p. Dep. NTIS, PC A03/MF A01.

Progress is reported on the following research projects: response of embryo regions to nutrition; synthesis of serum proteins by the yolk-sac; serum protein synthesis in relation to protein nutrition, protease secretion, teratogenic agents, genetic abnormalities, yolk-sac cell cultures, and cell free systems; and effects of serum proteins on rat embryos, chick embryos without yolk-sacs, and isolated brains. (HLW)

9053 Studies on the 1α,25-dihydroxycholecalciferol-like activity in a calcinagenic plant, Cestrum diurnum, in the chick. Wasserman, R.H. (Cornell Univ., Ithaca, NY); Corradino, R.A.; Krook, L.; Hughes, M.R.; Haussler, M.R. *J. Nutr.;* **106**: No. 4, 457-465(Apr 1976).

Cestrum diurnum (day-blooming jessamine) has been proposed to cause calcinosis in horses and cattle in Florida. The present studies investigated some physiological properties of the plant, using the chick as the experimental animal. The inclusion of dried leaf powder in a rachitogenic diet restored intestinal calcium-binding protein synthesis (CaBP) and increased calcium absorption in the cholecalciferol-deficient chick. The estimated level of cholecalciferol-equivalents in the dried leaf was about 30,000 to 35,000 IU/kg. Most of the activity was extractable with methanol : chloroform (2:1), indicating that the major cholecalciferol-like component in C. diurnum was different from the water soluble factor(s) in Solanum malacoxylon. The time course of effect of C. diurnum extract in rachitic chicks was similar to that of 1,25-dihydroxycholecalciferol but the former had a longer lag time. The strontium fed chick, in which the kidney 25-hydroxycholecaliciferol-1α-hydroxylase is inhibited, responded to C. diurnum extract, confirming the 1α,25-dihydroxycholecalciferol-like character of the Cestrum factor. The extract also appeared to interact with the intestinal 1α,25-dihydroxycholecalciferol cytosol receptor although this observation is preliminary. These findings indicate that the 1α,25-dihydroxycholecalciferol-like principle in C. diurnum may cause excessive calcium and phosphate absorption leading to calcinosis.

MEDICINE

REFER ALSO TO CITATION(S) 9058

9054 (PB—268227) **Improved instrumentation and techniques for non-invasive detection, characterization and quantification of atherosclerosis for research and diagnostic purposes. Annual report, 23 Jun 1975—22 Mar 1976.** Ovitt, T.W.; Nudelman, S.; Bartels, P.H.; Fernando, Q.; Carter, D.E. (Arizona Medical Center, Tucson (USA)). Apr 1976. Contract N01-HV-5-2969. 35p. NTIS PC A03/MF A01.

The program is a multifaceted research endeavor for the development and assessment of new and improved video instrumentation, image processing, contrast media, and techniques for noninvasive detection, characterization, and quantification of atherosclerosis. During this first nine-month period, the following has been achieved: (1) A detailed analysis of processing steps required for enhancement in conjunction with subtraction. (2) Construction of instrumentation needed for switching high voltages rapidly. (3) Design of a fast memory for digital processing of images. (4) Preliminary examination of iodine and dysprosium for the Bremsstrahlung method of subtraction with some positive results for iodine. (5) Enhancement was achieved of a high and a low contrast radiograph for corresponding significance probability maps generated by computer processing. The low contrast radiograph resulted in the better mapping and gives credence to the potential for this approach to provide clinically useful imagery from poor to nonvisual imagery in radiographs. (6) Metal complexes of gold, dysprosium, and europium have been synthesized and characterized.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 9029, 9049, 9095, 9097

9055 Exponential growth kinetics for Polyporus versicolor and Pleurotus ostreatus in submerged culture. Carroad, P.A.; Wilke, C.R. (Univ. of California, Berkeley). *Appl. Environ. Microbiol.;* **33**: No. 4, 871-873(Apr 1977).

Simple mathematical models for a batch culture of pellet-forming fungi in submerged culture were tested on growth data for Polyporus versicolor (ATCC 12679) and Pleurotus ostreatus (ATCC 9415). A kinetic model based on a growth rate proportional to the two-thirds power of the cell mass was shown to be satisfactory. A model based on a growth rate directly proportional to the cell mass fitted the data equally well, however, and may be preferable because of mathematical simplicity.

9056 Determination of bacterial number and biomass in the marine environment. Watson, S.W.; Novitsky, T.J.; Quinby, H.L.; Valois, F.W. (Woods Hole Oceanographic Institution, MA). *Appl. Environ. Microbiol.;* **33**: No. 4, 940-946(Apr 1977).

Three techniques for the measurement of bacterial numbers and biomass in the marine environment are described. Two are direct methods for counting bacteria. The first employs an epifluorescence microscope to view bacteria that have been concentrated on membrane filters and stained with acridine orange. The second uses a transmission electron microscope for observing replicas of bacteria that are concentrated on membrane filters. The other technique uses Limulus amebocyte lysate, an aqueous extract from the amebocytes of the horseshoe crab, Limulus polyphemus, to quantitate lipopolysaccharide (LPS) in seawater samples. The biomass of gram-negative (LPS containing) bacteria was shown to be related to the LPS content of the samples. A factor of 6.35 was determined for converting LPS to bacterial carbon.

TRACER TECHNIQUES

9057 Preparation of specifically labeled ^{14}C-(lignin)- and ^{14}C-(cellulose)-lignocelluloses and their decomposition by the microflora of soil. Crawford, D.L.; Crawford, R.L.; Pometto, A.L. III. *Appl. Environ. Microbiol.;* **33**: No. 6, 1247-1251(Jun 1977).

Microbial decomposition of lignocellulose in soil was studied using radioisotope techniques. Natural lignocelluloses containing ^{14}C in either their lignin or cellulose (glucan) components were prepared by feeding plants L-[U-^{14}C]phenylalanine or D-[U-^{14}C]glucose, respectively, through their cut stems. Detailed chemical and chromatographic characterization of labeled lignocelluloses from three hardwood and three softwood species showed that those labeled by the [^{14}C]glucose incorporation method contained specifically labeled cellulosic components, whereas those labeled by the [^{14}C]phenylalanine incorporation method contained specifically labeled lignin components. Microbial degradation of these differentially labeled lignocelluloses was followed by monitoring $^{14}CO_2$ evolution from selected soil samples incubated with known amounts of radiolabeled lignocelluloses. The lignin components of the six woods were shown to be decomposed in soil 4 to 10 times more slowly than their cellulosic components. These rates of mineralization were comparable to the generalized patterns previously reported in the literature. The present technique, however, was thought to be simpler, more sensitive, and less prone to interference than methods previously available.

PATHOLOGY

REFER ALSO TO CITATION(S) 9074, 9111

9058 (ORNL—5171, pp 85-90) **Ultrasonic pulse-echo determination of burn depth in partial-thickness burns.** Goans, R.E.; Cantrell, J.H. Jr.; Meyers, F.B.; Schneider, M.V. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

A number of possible techniques for measuring burn depth were considered, and it was concluded that high-frequency ultrasound offers the best possibility for investigation of burn injury. A conventional ultrasonic pulse-echo system was assembled and modified so that small distances in tissue (less than or equal to 1 mm) can be resolved. Typical transducers used during the course of measurements on human and porcine skin are described. Ultimate success of the ultrasonic technique is dependent on the validity of the assumption that the acoustic impedance of necrotic burn tissue is sufficiently different from that of viable tissue to allow for ultrasonic reflections at the interface between burned and viable tissue. In general, this assumption seems to have been valid in animal and human experiments carried out to date.

AGRICULTURE AND FOOD TECHNOLOGY

9059 Multielement absorption by crops grown on Ithaca sludge-amended soil. Furr, A.K. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Kelly, W.C.; Bache, C.A.; Gutenmann, W.H.; Lisk, D.J. *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 756-763(Dec 1976).

Absorption of 42 elements by plants representing major classes of edible garden crops on sludge-amended soil were studied. Sludge from the city of Ithaca, NY was used. The Ithica sludge process includes primary settling, trickle filtration, anaerobic digestion and finally vacuum filtration with the addition of lime. It had a pH of 7.2 and had remained in a pile outside for one year. The crops planted were: bush bean, cabbage, carrot, onion, tomato, millet and potato. Only the edible plant portions were collected for analysis. The sludge showed relatively high levels of Cd, Cr, Cu, Mo, Ni, Pb, Ti, and Zn. B, Br, Ca, Cd, Cl, Cr, Cu, Fe, Hg, I, Mo, Ni, Sb, Sc, Se, Ta, V, W and Yb were found higher in at least 3 of the crops grown during the first year on sludge-amended soil as compared to the control. Ca, Cd, Cl, Cu, Fe, I, Mo, Ni, W and Yb were most consistently high, their plant concentrations in the sludge-soil treatment exceeding those of the controls in 5 or more of the crops studied. Plant absorption of the elements B, Br, Cd, Cl, Cu, I and Ni would probably not be greatly affected by the higher pH (7.1) of the sludge-soil mixture as compared to the soil alone (5.3). Absorption of Ca, Mo and Se would be favored by the rise in pH while absorption of iron would tend to be decreased. Al, B, Br, Ca, Cd, Cu, Fe, and K were most consistently high in second year crops from the sludge-soil mixture. Cr and Cu were lower in second year crops. Ni in beans, Cd and Sb in onions and Hg in millet attained concentrations of some concern in the first year crops.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 9309

RADIATION EFFECTS ON BIOCHEMICALS

9060 (UCLA—12-1128) **Radiation damage to DNA in aqueous solution: effects of radiosensitizers.** Ward, J.F. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1977. Contract EY-76-C-03-0012. 17p. Dep. NTIS, PC A02/MF A01.

Systems are described for examining the molecular mode of action of anoxic radiosensitizers with DNA—OH radicals. Pulse radiolysis showed that NPPN reacts with these radicals even in the presence of 0.5mM oxygen. Analysis of low molecular weight products liberated from DNA by irradiation showed that NPPN does not act in an oxygen-like way but that misonidazole does. Thus a molecular rationale exists for the use of combinations of radiosensitizers.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

9061 (COO—1671-73) **Theory of RBE. Progress report, January 1, 1977—December 1977.** Katz, R. (Nebraska Univ., Lincoln (USA)). Sep 1977. Contract EY-76-S-02-1671. 8p. Dep. NTIS, PC A02/MF A01.

Emulsion-processing combinations have been found which match the response of mammalian cells to x-rays. The grain size of these emulsions is in the implied range of sensitive element sizes in biological cells. The fading of the latent image may parallel biological repair. In consequence studies are under way of the variation in emulsion response to low LET radiations of different quality, of "Elkind repair", and of dose fractionation. Predictions of OER and RBE of mammalian cells to high LET radiations, from track structure theory, have been verified, once again, in Bevalac experiments. Experiment has now shown that high temperature traps in LiF respond favorably to neutrons, while low temperature traps respond favorably to gamma-rays. This result is consistent with our identification of supralinear high temperature traps as from an unidentified 2-hit trap structure. In collaboration with Oak Ridge colleagues, Monte-Carlo studies of the electron slowing down spectra of source electrons from 1 keV to 1 MeV in liquid water are being integrated into the theory of RBE. The yield of several different ions is nearly independent of the initial energy of source electrons. The results raise questions as to the physical basis for biological observations of RBE differences for x- and gamma-rays.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

9062 (N—77-21822) **Ground-based dosimetry support for experiment AR002.** Cassou, R.; Benton, E.V. (San Francisco Univ., Calif. (USA). Dept. of Physics). 1976. Contract NAS9-14396. 12p. (NASA-CR—151245). NTIS PC A02/MF A01.

Actinomyces levoris colonies were exposed to alpha particles at the 184-inch cyclotron, and Streptomyces levoris colonies were exposed to Ne-20 ions. A description is given of the experimental conditions for each experiment along with tables listing the doses delivered to the colonies. The doses for the Actinomyces levoris exposures came from calibrations made by the cyclotron operators, while the doses for the Streptomyces levoris exposures came in part from cave calibrations and also in part from calculations.

9063 Inactivation by ionizing radiation of Salmonella enteritidis serotype montevideo grown in composed sewage sludge. Brandon, J.R.; Burge, W.D.; Enkiri, N.K. (Sandia Labs., Albuquerque, NM). *Appl. Environ. Microbiol.;* **33**: No. 4, 1011-1012(Apr 1977).

S. enteritidis ser. montevideo were grown in composted sewage sludge to levels of approximately 10^9/g. These bacteria were found to be inactivated by ionizing radiation (with Co_{60}) at approximately the same rate (30 krads/log) as Salmonella species in liquid digested sludge.

RADIATION EFFECTS ON ANIMALS

REFER ALSO TO CITATION(S) 9072

MAN

REFER ALSO TO CITATION(S) 9120

9064 (N—77-23045) **Implications of outer-zone radiations on operations in the geostationary region utilizing the ae4 environmental model.** Wilson, J.W.; Denn, F.M. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). May 1977. 70p. (NASA-TN-D—8416; L—11280). NTIS PC A04/MF A01.

The radiation exposure in the region of geostationary orbits is examined in search for means of optimizing human performance. It is found that the use of slightly inclined circular orbits is one means by which exposure and spacesuit thickness requirements can be reduced. Another effective technique is to limit the extravehicular activity to those days when the short term fluctuations result in low exposure. Space-suit shielding approaching 1/2 sq cm or less may be possible by utilizing work stoppages and inclined orbits. If aluminum and other low-atomic-number materials are used to construct the habitat, then excessive wall thicknesses are required. If special bremsstrahlung shielding is used, then the habitat shield may be reduced to as low as 2 g/sq cm. Numerous tables and graphs are presented for future analysis of dose in the geostationary region.

9065 (ORNL—5171, pp 68) **Absorbed dose to mammary glands.** Warner, G.G.; Poston, J.W. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The radiation dose absorbed in the female breast(s) as a result of various x-ray exposures was calculated. To the 70-kg computerized phantom used in BRHGAM (a dose estimation program) have been added the mathematical descriptions of two female breasts. For these initial studies, the composition of the breasts was tissue-equivalent. Investigations are under way to determine if there should be a more realistic composition in BRHGAM. Five cases have thus far been simulated on the computer.

9066 (ORNL—5171, pp 81-82) **In-phantom spectrometry of medical x rays.** Stansbury, P.S.; Poston, J.W. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The performance of a NaI(Tl) scintillation detector used to measure the spectral fluence at various locations inside the MR. ADAM phantom exposed to x-ray fields simulating medical diagnostic radiological examinations was tested. Both in-beam and out-of-beam measurements will be performed, and the distortions in the measured spectra due to Gaussian broadening will be removed. The detector will be positioned so as to minimize the distortions due to x rays entering the detector parallel or nearly parallel to the axis of the light pipe. Under the geometrical conditions required by this project, it is believed that the performance of the spherical NaI(Tl) spectrometer will be superior to the performance of a more conventional spectrometer.

9067 (ORNL—5171, pp 83) **Evaluation of the distribution of absorbed dose in pediatric phantoms exposed to diagnostic medical x rays.** Chen, W.L.; Poston, J.W. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The distribution of absorbed radiation dose in pediatric phantoms exposed to diagnostic medical x rays was studied. Phantoms representing a one-year-old and a five-year-old child were used.

9068 (ORNL—5171, pp 283-294) **Dosimetry for human exposures.** Kerr, G.D.; Cheka, J.S.; Marks, S.; Jones, T.D.; Hwang, J.M.L.; Miller, F.L; Yamada, H.; Auxier, J.A.; Jones, R.M.; Solomon, D.L. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Absorbed doses to human active (red) bone marrow from neutrons with energies between 0.025 eV and 14 MeV and gamma rays with energies between 50 keV and 10 MeV have been calculated for anterior-posterior (AP), posterior-anterior (PA), bilateral, rotational, and isotropic whole-body irradiation of an ICRP reference man analog. These calculations are discussed and are compared with experimental gamma-ray measurements for anterior-posterior, rotational, and isotropic exposures available in the literature.

9069 (ORNL—5171, pp 361-362) **Analytic dosimetry.** Turner, J.E.; Loebl, A.S.; Holoway, C.F.; Houser, B.L. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The analytic dosimetry program was established to serve as a focal point where technical questions could be directed to assist researchers in the Health Physics Division as well as individuals and organizations outside the Division. Ready access to the entire Division staff enables the group to respond to a wide variety of needs within the broad interdisciplinary areas associated with health physics. The group also functions in a core operation of gathering information, compiling bibliographies, and adding critical judgment on various subjects to assist the Division's research programs. This activity, which parallels responding to specific questions, also provides researchers the opportunity to review specific problems in some depth and to synthesize and evaluate what is known about them. Files developed from both these activities are abstracted. The abstracts are made machine-readable and put into the computerized Health Physics Information System (HPIS), which is one of the data bases managed through the Information Division. Like the other computerized data bases at Oak Ridge National Laboratory, HPIS files are available and accessible to searches by any user with access to the local Information Center Complex.

9070 (PB—268358) **Alleged injuries involving use of ultraviolet radiation in dentistry. Interim report.** Mills, L.F. (Bureau of Radiological Health, Rockville, Md. (USA). Div. of Biological Effects). Jun 1977. 11p. (FDA/BRH—77/124). NTIS PC A02/MF A01.

Two hundred and nine reports of alleged injury associated with the use of ultraviolet photopolymerization in the oral cavity were reviewed and tabulated. More than half of the 232 injured persons were dentists. Eye injuries were the most frequent. The injuries reported in this review are not representative of a comprehensive effort at casefinding. Instead, they are typical reports submitted by dentists to the manufacturer. The injuries reported appear to reflect the nature of dental practice, and the exposure sites are consistent with the three types of persons involved in the dental procedure.

9071 (UCRL—79428) **Transnational air quality: the case for the stratosphere.** Knox, J.B.; Dickerson, M.H.; Lange, R.; Peterson, K.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1977. Contract W-7405-ENG-48. 28p. (CONF-770934—1). Dep. NTIS, PC A03/MF A01.

From 8. international technical meeting on air pollution modeling and its application; Louvain-la-Neuve, Belgium (20 Sep 1977).

The new Concorde flight corridors will be at approximately the same height as the debris cloud trajectories of recent high yield Chinese weapons tests. In response to this perception, the FAA with other U.S. agencies is formulating a concept for a Stratospheric Environmental Assessment Capability (SEAC) whose objective is to furnish timely and accurate predictions of in-cabin environmental radiation dose-to-man estimates in the event of future nuclear tests. Modeling elements of the proposed SEAC are illustrated on the high yield Chinese test of November 17, 1976, wherein the debris cloud intersected the North Atlantic flight corridors several days after detonation and resulted in whole-body gamma dose rates of about 1 millirem per hour above background. Had the flight levels been a few kilometres higher, the estimated dose would have been 30 percent higher. The potential exposures on stratospheric flight corridors of the Pacific were estimated to be about 200 to 300 mr/hr, a level warranting diversion of some flight paths. The technical basis and modeling capabilities involved in SEAC will be reviewed along with perceptions of transferrable experience in the stratosphere to other transnational air quality problems.

VERTEBRATES

9072 (ORNL—5171, pp 241-245) **Health physics research reactor.** Dickson, H.W.; Ward D.R.; Holland, L.B. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The Health Physics Research Reactor (HPRR) is a principal research tool for the Dosimetry Applications Research Facility (DOSAR). The HPRR can be operated either as a pulse reactor with fission yields up to 10^{17} or at steady-state power levels up to 10 kW. This reactor is an unshielded and unmoderated assembly that provides mixed neutron and gamma-ray fields. The HPRR is continually used as a versatile radiation source for a number of dosimetry and radiobiology studies. Most of these studies are directed toward correlating biological response with absorbed dose. Some of the important continuing radiobiology experiments which utilized the HPRR this year were investigations of lens opacities in mice exposed to fission neutrons, effects of low doses of neutrons on the early embryonic stages of the mouse, dose and dose-rate effects in tumor induction due to high-LET radiation, and effects of neutron irradiation on grain and flowering plants. In an effort to more precisely characterize the radiation fields at the HPRR, a thermoluminescent dosimetry (TLD) system was developed. The use of the HPRR for training and for dosimetry intercomparisons is discussed.

9073 **Allotransplantation of the lung without immunosuppression after transplantation. II. Combined autotransplantation of bone marrow and allotransplantation of lung.** Blumenstock, D.A.; Cannon, F.D.; Franck, W.A.; Hales, C.A.; Kazemi, H.; Ferrebee, J.W. (Co-

lumbia Univ., Cooperstown, NY). *Transplantation;* **24**: No. 3, 194-200(Sep 1977).

A series of seven animals underwent allotransplantation of a lung from a donor matched for the recognition of serologically defined (SD) antigens by the use of alloantisera followed by autotransplantation of bone marrow without further immunosuppression. In two animals, the lung was transplanted into the recipient immediately before the administration of total-body irradiation and in five, the lung was transplanted after completion of total-body irradiation. In the first group, one animal is living at 46 months with good function of the transplant. The other was killed at 6 months with chronic rejection. In the second group, three of five animals are alive 46 to 47 months after transplantation. Two others died early, one of cardiac tamponade and the other of diffuse hemorrhage before engraftment of marrow could be accomplished. Significant function of the transplant was demonstrated in all long-term survivors. Four control animals, subjected to marrow harvest and reimplantation of the left lung followed by total-body irradiation and marrow reinfusion, were studied to determine the possible deleterious effects of the total-body irradiation and marrow transplant procedure. Pulmonary function studies showed some reduction in ventilation and perfusion to the upper lobe areas, which was probably related to technical factors but did demonstrate no severe adverse effects to the procedures. Autologous bone marrow reconstitution after total-body irradiation combined withallotransplantation of the lung has allowed long-term survival and function of lung transplants without the necessity for administration of immunosuppressive drugs after the transplantation procedure.

9074 **Radiation-induced erythroleukemia in the beagle dog.** Tolle, D.V.; Fritz, T.E.; Norris, W.P. *Am. J. Pathol.;* **87**: No. 3, 499-510(Jun 1977).

Eleven cases of myeloproliferative disease occurred in a group of 24 beagle dogs placed in a ^{60}Co γ-ray field at about 13 months of age and irradiated at an exposure rate of 5 R/22-hour day for duration of life. Of these 11 dogs, 5 were diagnosed as having erythroleukemia. The bone marrow showed marked erythroblastic hyperplasia, with maturation arrest of the erythroid elements, and increased numbers of myeloblasts and promyelocytes. The terminal peripheral blood was characterized by marked anemia and thrombocytopenia, with circulating erythrocytic precursors and abnormal erythrocyte morphology. Splenomegaly and hepatomegaly occurred in 4 of the 5 animals. In the spleens and livers of all 5, there was extensive leukemic infiltration and proliferation. The extent of leukemic involvement in other tissues and organs varied in individual dogs.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 9069, 9120

9075 (ORNL—5171) **Health Physics Division. Annual progress report for period ending June 30, 1976.** Auxier, J.A.; Davis, D.M.; Turner, J.E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1976. Contract W-7405-ENG-26. 395p. Dep. NTIS $11.00.

Separate abstracts were prepared for each section.

9076 (ORNL—5171, pp 1-11) **Maximum permissible concentration (MPC) values for spontaneously fissioning radionuclides.** Ford, M.R.; Snyder, W.S.; Dillman, L.T.; Watson, S.B. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The radiation hazards involved in handling certain of the transuranic nuclides that exhibit spontaneous fission as a mode of decay were reaccessed using recent advances in dosimetry and metabolic modeling. Maximum permissible concentration (MPC) values in air and water for occupational exposure (168 hr/week) were calculated for ^{244}Pu, ^{246}Cm, ^{248}Cm, ^{250}Cf, ^{252}Cf, ^{254}Cf, /sup 254m/Es, ^{255}Es, ^{254}Fm, and ^{256}Fm. The half-lives, branching ratios, and principal modes of decay of the parent-daughter members down to a member that makes a negligible contribution to the dose are given, and all daughters that make a significant contribution to the dose to body organs following inhalation or ingestion are included in the calculations. Dose commitments for body organs are also given. (CH)

9077 (ORNL—5171, pp 12-16) **Specific absorbed fractions for photons emitted in the walls of the GI tract.** Deus, S.F.; Provenzano, V.; Snyder, W.S. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The specific absorbed radiation dose fractions in target organs were calculated for photon sources in the stomach and upper and lower large intestine using an improved human phantom in which the radioactivity in the contents and walls of the gastrointestinal tract are separated. Computer calculations based on the Monte Carlo method and energy loss to each organ of the phantom during decay of the radionuclide were used. (CH)

9078 (ORNL—5171, pp 17-19) **Dose to the stomach wall from injected /sup 99m/Tc pertechnetate.** Ford, M.R.; Deus, S.F.; Snyder, W.S. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Methods used for computer calculations of the radiation dose to the stomach wall from injected /sup 99m/Tc pertechnetate are described. (CH)

9079 (ORNL—5171, pp 23-26) **Dose commitment estimates based on urinary and fecal excretion data for the case of human exposure to $^{238}PuO_2$.** Bernard, S.R. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The metabolic model reported by Stuart and his colleagues was used for the case of inhalation of $^{239}PuO_2$ by beagles to interpret an unusual set of urinary excretion data for the inhalation of $^{238}PuO_2$ by a human. These data were plotted on a semilogarithmic graph. The ordinate plots the dis/min 24 hr^{-1} urine, and the abscissa is the approximate time in days after the intake. There are three distinct peaks in excretion between 400 and 600 days, at which time diethylenotriaminopentaacetic acid (DTPA) was administered. In order to estimate organ burdens, the effect of DTPA was ignored, and a single exponential was used to approximate the excretion data. Preliminary 50-year dose estimates for liver, kidneys, and lungs were made. It is pointed out that metabolic models based on $^{239}PuO_2$ inhalation in dogs may not be accurate for $^{238}PuO_2$ in man.

9080 (ORNL—5171, pp 27-40) **Estimates of photon dose to the gonads per microcurie-day as a function of the source organ and the age of the individual.** Snyder, W.S.; Ford, M.R.; Poston, J.W.; Warner, G.G. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

When a photon emitter is present in the body, essentially all the body is irradiated. Thus the gonads will receive some irradiation, but the amount will reflect the geometrical locations of the source and the target organs as well as the energy of the photons. To estimate the average genetic dose to the population, one needs to know the photon dose as a function of body size or age. Using an average body size for each age, one finds that the dose per microcurie-day increases rather regularly as age or body size decreases. This is the first complete presentation of doses per microcurie-day for the gonads. Doses (rads per microcurie-day) are given for a monoenergetic source of photons of yield 1 photon per nuclear transformation.

9081 (ORNL—5171, pp 41-44) **Estimates of radiation dose to the embryo from nuclear medicine procedures.** Smith, E.M.; Warner, G.G. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The estimate of the radiation absorbed dose to the embryo is important when a radiopharmaceutical has been intentionally or unknowingly administered to a female who is at the beginning of her pregnancy. Currently, there are no direct methods of calculating the dose to the embryo. The dose to the uterus can be calculated and assumed to be equal to the dose to the embryo. Methods for the computation are described.

9082 (ORNL—5171, pp 45-49) **Practical methods of dose reduction to the bladder wall.** Smith, E.M.; Warner, G.G. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The design objective for contemporary radiopharmaceuticals used in nuclear medicine is rapid and specific localization in the tissues to be imaged, followed by rapid elimination of the radionuclide via the kidneys and bladder. Thus the bladder should be one of the primary organs considered when dose estimates are made for current and future radiopharmaceuticals. The accumulated dose to the bladder wall can be quite significant, since it is subject to irradiation from most nuclear medicine procedures at relatively high levels compared with other tissues of the body. The activity in the contents of the bladder irradiates not only the bladder wall but also tissues in close proximity to the bladder. A substantial dose reduction to both the bladder wall and, possibly, nearby organs could be achieved if the urine volume and the time during which the excreted activity remained in the bladder were optimized in a manner compatible with most patients and the clinical environment. The purpose of this study was to determine what parameters affect the mean dose to the bladder wall and to suggest methods of optimizing these parameters to minimize the mean dose.

9083 (ORNL—5171, pp 50) **Estimation of dose commitment from an accidental intake of ^{244}Cm.** Bernard, S.R.; Poston, J.W. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Four employees at the Oak Ridge National Laboratory inhaled ^{244}Cm as a result of an accidental release of this radionuclide. Urine and fecal samples were analyzed and Bioassay Laboratory chest counts were made with a whole-body counter. Ca-DTPA mists were inhaled within hours after the intake. These data, together with data on the inhalation of ^{244}Cm in the dog, were used to obtain a 50-year dose commitment to lungs, skeleton, and liver. The 50-year dose commitment to skeleton for two of the employees was estimated to be about 170 rems. The estimation methods used for dose commitment, together with the values for other organs, are presented and discussed.

9084 (ORNL—5171, pp 51) **Fifty-year dose commitment to various organs and tissues from inhalation of ^{133}Xe.** Bernard, S.R.; Snyder, W.S. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Metabolic models for a single inhalation of ^{133}Xe, together with computer calculations, were employed for estimating dose commitments to various organs and tissues in the adult human body. The code uses the Monte Carlo data for photons and assumes complete absorption of the energy from the emitted electrons in organs and tissues. For bone, the dose to red and yellow marrow and to endosteal cells of both trabecular and cortical bone was estimated. For a single inhalation of 1 mCi of ^{133}Xe, the 50-year dose to gonads was about 0.4 millirad. The dose to lungs from ^{133}Xe dissolved in tissues was about the same; however, the dose to the lungs from ^{133}Xe in air spaces was about 1 millirad.

9085 (ORNL—5171, pp 53-54) **Dose-conversion factors for some fission products.** Poston, J.W.; Bernard, S.R.; Ford, M.R.; Watson, S.B.; Snyder, W.S. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Dose-conversion factors are presented that provide estimates of dose per microcurie inhaled for 54 fission product radionuclides. The data are given in a table which lists the isotope with the clearance class indicated and the value of f_1. The units are changed to rems per curie inhaled as being somewhat more familiar.

9086 (ORNL—5171, pp 55-58) **Improved radioactive decay scheme data.** Dillman, L.T. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

A computer program to generate decay scheme information in a format suitable for dosimetry calculations is discussed. The program takes basic decay scheme data available from the literature or from compilations such as the Nuclear Data Sheets and calculates additional parameters needed in dosimetry work. The most important additional parameters include the average energy of β^+ and β^- particles and the energies and intensities of x-ray and Auger electrons generated as a result of the radioactive decay process. This paper summarizes a number of improvements and refinements that have been incorporated in this computer program.

9087 (ORNL—5171, pp 59-63) **Distributions of absorbed dose from isotropic and half-space isotropic irradiation by monoenergetic neutrons and photons.** Jones, T.D. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Monte Carlo transport codes were used to calculate distributions of absorbed dose from isotropic and half-space isotropically incident cloud sources of monoenergetic neutrons and photons. Coordinates and direction cosines of individual source particles, incident on a cylindrical phantom, were simulated from algorithms. The resulting depth-dose distributions are intended primarily for use in radiation protection and risk analyses.

9088 (ORNL—5171, pp 64-67) **Preliminary considerations in the use of large planar intrinsic germanium detectors for detection of internally deposited actinides.** Bemis, C.E.; Goans, R.E.; Good, W.M.; Warner, G.G. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The impact of silicon and germanium semiconductor detectors for the measurement of low-energy photons from internally deposited actinides is discussed. The energy resolution enhancement offered by Ge semiconductor detectors more than offsets the inferior detection efficiency, and in counting situations where the precision tends to be poor, the use of Ge detectors is clearly desirable. The inherent gain stability and high resolution of semiconductor spectrometers greatly add to the practitioner's confidence in making such measurements. In the lower-photon-energy domain of about 10 to 150 keV, both the Ge semiconductor and the sodium iodide scintillation spectrometers are black to photons, and the absolute detection efficiencies are, for the most part, governed by solid-angle considerations. In this energy range, the superior resolving power of Ge detectors is evident, and their use in low-intensity health physics applications is extremely desirable. One particular health physics application that could greatly benefit is the in-vivo detection of respired actinide nuclides using external detectors. This study represents some of our preliminary efforts to define and parameterize some of the variables involved in this particular application.

9089 (ORNL—5171, pp 69-75) **Pediatric phantoms.** Shoup, R.L.; Hwang, J.L. Warner, G.G.; Poston, J.W. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Phantom designs of children of ages newborn, one year, and five years have recently been completed. The phantoms are heterogeneous and consist of a skeletal system and 22 internal organs. The volumes for the whole bodies of children represented by these phantoms were found through the use of available data of specific gravity as a function of age. The specific gravities for children tend to be lower than those for adults. Once the total volume of the body was established, the volume of each part (head, trunk, arms, and legs) was partitioned. The volume percentages of the different parts of the total volume were not the same for the three ages. In designing the phantoms, the volumes for trunk and arms were composited and referred to as the volume of the trunk section. Applications of the phantoms in calculating the absorbed radiation dose from biologically distributed radionuclides are discussed.

9090 (ORNL—5171, pp 76-79) **Development of a mathematical phantom representing a ten-year-old for use in internal dosimetry calculations.** Deus, S.F.; Poston, J.W. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

A phantom was developed representing a ten-year old child for use as the basis for dosimetric studies. An initial literature survey was made to determine organ mass, shape, and location in a normal ten-year-old child. These data were used to construct a mathematical representation of the child for use in computer calculations of absorbed radiation dose for typical exposure situations following the administration of radiopharmaceuticals.

ANIMALS

REFER ALSO TO CITATION(S) 9079

MICROORGANISMS

9091 (ORNL-tr—4476) **Uptake of cobalt, lead, and cadmium by Baker's yeast.** Heldwein, R.; Tromballa, H.W.; Broda, E. Translated by D. Jacobson from *Z. Allg. Mikrobiol.;* **17**: No. 4, 299-308(1977). 13p. Dep. NTIS, PC A02/MF A01.

The toxicity for and the uptake by Seccharomyces cerevisias of the essential trace element Co^{2+} and the non essential elements Cd^{2+} and Pb^{2+} were compared. Inhibition of yeast growth is observed 4 hrs after addition of Co at concentrations higher than 10^{-4} M. Cd is about 100 times more toxic than Co and inhibits growth immediately after addition. No toxicity of Pb is observed with concentrations up to 5.10^{-4} M. For uptake experiments the radioactive isotopes ^{60}Co, /sup 115m/Cd and ^{210}Pb were used. Co uptake by yeast is strongly dependent on glucose both under aerobic and anaerobic conditions. There is no efflux of Co once taken up. Dead yeast does not accumulate Co at all. Co already taken up is released from cells when killed, indicating that no irreversible binding in the cell interior takes place. Co transpot follows biphasic saturation kinetics with the MICHAELIS constants $K_1 = 10^{-4}$ and $K_2 = 8 . 10^{4}$M and the maximal velocities $v_1 = 9.5$ and $r_2 = 63$ μ moles/g dry weight . hr. The Q_{10} for Co uptake from 10^{-4} M solution is 2.3. Uptake of Cd resembles that of Co. The absorption of Cd is also glucose-dependent, but independent of the presence of air, no Cd is taken up by dead cells, and Cd previously taken up is released during killing the cells. There is a considerable Pb uptake irrespective of the presence of glucose, and even by dead yeast. Killing ofthe yeast during uptake does not lead to loss of Pb. It is concluded that the essential trace element Co is accumulated by an energy-dependent, probably active, transport system in the membrane. Cd is similarly transported, probably because of its chemical similarity to Zn. In contrast, Pb appears to be taken up only by diffusion, but subsequently to be trapped by binding in the cell interior. In this way, the accumulation of Pb is similar in amount to those of Co or Cd although the mechanisms differ widely.

NUCLIDE KINETICS AND TOXICOLOGY

REFER ALSO TO CITATION(S) 8113

MAN

REFER ALSO TO CITATION(S) 9071

ANIMALS

REFER ALSO TO CITATION(S) 9031

9092 (ORNL—5171, pp 20-22) **Metabolic model studies of ^{75}Se retention in rats fed or injected with different levels of stable selenium.** Bernard, S.R. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The effects of various levels of ingested or injected stable Se on the uptake and whole-body retention time of a tracer dose of intravenously injected $^{75}SeO_3$ were studied in rats. Computer calculations were used to develop a metabolic model. (CH)

9093 **Biokinetics of ^{237}Np in mussels and shrimp.** Guary, J.C.; Fowler, S.W. (International Lab. of Marine Radioactivity, Monaco). *Mar. Sci. Commun.;* **3**: No. 3, 211-229(1977).

Neptunium-237 kinetics were studied in marine shrimp and mussels using a thick source alpha counting technique. Bioaccumulation of ^{237}Np from water was relatively slow in both species, reaching whole body concentration factors of only 15 to 20 after three months. Surface adsorption was implicated in the initial uptake. Both uptake and loss of the radioisotope were not significantly affected by temperature; this may be a reflection of the physical nature of the uptake. By virtue of the large amounts of accumulated ^{237}Np associated with the exoskeleton of shrimp, molting will play an important role in the biogeochemical cycling of this transuranic in the marine environment. Rapid growth of organisms like mussels acts to reduce the ^{237}Np concentration in tissues during a period of decontamination.

PLANTS

9094 (ORO—4066-11) **Investigation of the unusual behavior of cesium-137 and other radionuclides in the Florida environment. Progress report, September 1, 1976—November 31, 1977.** Gamble, J.F. (Florida Univ., Gainesville (USA)). 1977. Contract EY-76-S-05-4066. 49p. Dep. NTIS, PC A03/MF A01.

A pangola digitgrass experiment with treatments inoculated with endomycorrhizal species has been planted in meter-square plots in a fumigated soil in south-central Florida. The first harvest was made after two months growth. Yield differences were minimal between treatments, the non-mycorrhizal control plots were slightly higher. Cesium-137 activity levels were ten times that of pangolagrass in the area. Yields after the second harvest, one month later, were similar and cesium-137 activity was four times that of established fields. The established fields of pangolagrass range from 35 to 75% mycorrhizal infection of their roots. After four months, mycorrhizal control in the check plots continued to be nearly complete. A greenhouse experiment utilizing a fungicide for mycorrhizal control in a field soil failed to limit development of endophyte infection on pangolagrass. Another greenhouse study using inoculations of two indigenous species of V.A. mycorrhizae did not show any differences in growth or uptake of radiotracer cesium-134 between mycorrhizal and non-mycorrhizal plants. In both experiments, the non-mycorrhizal pangola in sterilized soil grew as well or slightly better than inoculated pangola or pangola growing in naturally V.A. mycorrhizal soil. Neither were there any growth differences between treatments as the plants depleted the soil nutrients in the pots and died after six months. A low level of nitrogen was the only nutrient added to the pots.

THERMAL EFFECTS

MICROORGANISMS

9095 **Cell growth and catecholase production for Polyporus versicolor in submerged culture.** Carroad, P.A.; Wilke, C.R. (Univ. of California, Berkeley). *Appl. Environ. Microbiol.;* **33**: No. 4, 836-839(Apr 1977).

Cell growth and catecholase production for Polyporus versicolor (ATCC 12679) were studied in mechanically agitated submerged culture, as functions of temperature. The exponential-phase growth rate exhibited a maximum at 28°C. Over the range of 20°C to approximately 30°C, both cell mass and enzyme yield factors were constant. At higher temperatures (30 to 40°C) cell mass yield factor decreased and enzyme yield factor increased. Specific respiration rate of P. versicolor was determined. Thermal deactivation of catecholase was investigated between 30 and 50°C, and deactivation rates were fit to an Arrhenius rate expression.

PLANTS

REFER ALSO TO CITATION(S) 8006

INVERTEBRATES

REFER ALSO TO CITATION(S) 9034

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 8043

CELLS

REFER ALSO TO CITATION(S) 7920

MICROORGANISMS

REFER ALSO TO CITATION(S) 7886, 9049

9096 **Response of microorganisms to an accidental gasoline spillage in an Arctic freshwater ecosystem.** Horowitz, A.; Atlas, R.M. (Univ. of Louisville, KY). *Appl. Environ. Microbiol.;* **33**: No. 6, 1252-1258(Jun 1977).

The response of microorganisms to an accidental spillage of 55,000 gallons of leaded gasoline into an Arctic freshwater lake was studied. Shifts in microbial populations were detected after the spillage, reflecting the migration pattern of the gasoline, enrichment for hydrocarbon utilizers, and selection for leaded-gasoline-tolerant microorganisms. Ratios of gasoline-tolerant/utilizing heterotrophs to "total" heterotrophs were found to be a sensitive indicator of the degree of hydrocarbon contamination. Respiration rates were elevated in the highly contaminated area, but did not reflect differences between moderately and lightly contaminated areas. Hydrocarbon biodegradation potential experiments showed that indigenous microorganisms could extensively convert hydrocarbons to CO_2. In situ measurement of gasoline degradation showed that, if untreated, sediment samples retained significant amounts of gasoline hydrocarbons including "volatile components" at the time the lake froze for the winter. Nutrient addition and bacterial inoculation resulted in enhanced biodegradative losses, significantly reducing the amount of residual hydrocarbons. Enhanced biodegradation, however, resulted in the appearance of compounds not detected in the gasoline. Since the contaminated lake serves as a drinking water supply, treatment to enhance microbial removal of much of the remaining gasoline still may be advisable.

9097 **Identification of the virucidal agent in wastewater sludge.** Ward, R.L. (Sandia Labs., Albuquerque, NM); Ashley, C.S. *Appl. Environ. Microbiol.;* **33**: No. 4, 860-864(Apr 1977).

Anaerobically digested sludge contains an agent that causes irreversible inactivation of poliovirus. It has now been shown that the agent responsible for this activity is ammonia. The effect of ammonia on poliovirus appears to be typical for picornaviruses, but reovirus, an enteric virus of another group, is quite resistant to this compound. Because ammonia is not virucidal in its charged state, it expresses significant activity only at pH values greater than 8. Therefore, increasing the pH of sludge should cause rapid inactivation of indigenous picornaviruses.

9098 **Phytoplankton responses to phosphorus and silica enrichments in Lake Michigan.** Schelske, C.L.; Simmons, M.S.; Feldt, L.E. (Univ. of Michigan, Ann Arbor). *Verh. Internat. Verein. Liminol.;* **19**: 911-921(Oct 1975).

Effects of nutrient additions on natural phytoplankton assemblages in Lake Michigan were investigated. Phosphorus added at 10 and 20 μg P/l increased rates of carbon fixation and chlorophyll production. In some experiments added silica and river water diluted 1:100 also increased rates of carbon fixation and chlorophyll production.

PLANTS

REFER ALSO TO CITATION(S) 9005, 9009, 9059

9099 **Effect of SO_2 polluted air upon enzyme activity in plants originating from areas with different annual mean atmospheric SO_2 concentrations.** Horsman, D.C.; Wellburn, A.R. (Univ. of Lancaster, Eng.). *Environ. Pollut. (London);* **13**: No. 1, 33-39(May 1977).

Plants of the broad-leaved dock (Rumex obtusifolius), originating from areas with different annual mean atmospheric SO_2 concentrations, were exposed to charcoal filtered air or 0.2 ppM SO_2 (approximately equivalent to 520 μg SO_2/m^3) for 11 days. Comparisons were made of the levels of activity of ribulose-diphosphate carboxylase (RuDPC), glutamatepyrurate transaminase (GPT), glutamate-oxaloacetate transaminase (GOT) and peroxidase in leaf ex-

tracts from the plants. The effects of the sulfur dioxide fumigation varied, depending on the age of the plant leaves and the area of origin of the plants. The differential response to SO_2 exposure between the plants from the high mean SO_2 area and the low mean SO_2 area suggested that adaptation to the polluted conditions prevailing in the high mean SO_2 area may have occurred in the plants originating from that area.

INVERTEBRATES

REFER ALSO TO CITATION(S) 8005

9100 Effects of heavy metals on survival and respiration rate of tubificid worms. Part I. Effects on survival. Brkovic-Popovic, I.; Popovic, M. (Dept. of Waste Water Treatment Research, Sarajevo, Yugoslavia). *Environ. Pollut. (London);* **13**: No. 1, 65-72(May 1977).

Toxicity tests were performed with Tubifex tubifex in dynamic conditions. Median lethal concentrations (LC_{50}) and the confidence limits were determined for cadmium, copper, mercury, zinc, chromium and nickel during exposure for 24 and 48 h in four diluents of different total hardness and alkalinity. The results of our experiments indicated that the toxicity effects of all heavy metals tested on the survival of T. tubifex depended considerably upon the hardness and alkalinity of the diluent used. The relationship between 48-h LC_{50} for the tested metals and alkalinity of water in a log-log system are defined as rectilinear functions. Hardness and alkalinity of dilution water have a much slighter effect upon the toxicity of mercury than upon the other metals tested.

9101 Effects of crude oil on the locomotory activity of Arctic marine invertebrates. Percy, J.A.; Mullin, T.C. (Arctic Biological Station, Ste. Anne de Bellevue, Can.). *Mar. Pollut. Bull.;* **8**: No. 2, 35-40(Feb 1977).

The effects of exposure to seawater dispersions of northern crude oils on the locomotory activity of two Arctic marine invertebrates, the amphipod Onisimus affinis and the coelenterate Halitholus cirrattus have been examined. Low concentrations of the oils significantly impair activity in both species. The ecological implications of such sublethal effects may be important.

9102 Uptake and accumulation of the nickel ion by Mytilus edulis. Friedrich, A.R.; Filice, F.P. (Univ. of San Francisco, CA). *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 750-755(Dec 1976).

Following collection, mussels were cleaned, placed in "Instant Ocean" and left in holding tanks for two weeks to acclimatize to laboratory conditions. Animals were placed in five bio-assay tanks with 0.013, 0.025, 0.051 and 0.102 mg/l nickel. A second trial used concentrations of 20, 40, and 80 mg/l. An analysis of the soft parts of the frozen M. edulis for the presence of nickel consisted of wet digestion combined with flame atomic absorption spectrophotometry using a Perkin Elmer Model 303 spectrophotometer. A significant uptake and accumulation is shown for mussels in 20, 40, and 80 Mg Ni/l. No animals died during the experiment. Mussels secreted byssal threads in concentrations of 20 mg Ni/l, but not at 40 mg Ni/l and higher. As protection from toxic environments, a bivalue can close its shell which would reduce byssal thread formation. The accumulation of nickel by M. edulis may be due to an inadequate excretion of nickel. While uptake via food particles or other organisms is quite feasible, the 96 hour experiments point to a mucus sheet or transmembrane absorption, since the mussels were not fed for the duration of the 96 hour experiments.

9103 Copper toxicity in the Pacific oyster Crassostrea gigas. Okazaki, R.K. (Univ. of California, Bodega Bay). *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 658-664(Dec 1976).

A laboratory study was designed to determine the lethal concentration of Cu to the Pacific oyster. Oysters 18 to 24 months old and sexually mature were held in running unfiltered sea water (33 percent), pH8, at 12 to 15°C for one week prior to testing. The oysters were exposed to Cu concentrations of 0.10, 0.25, 0.50, 0.75, and 1.00 ppM for three separate 96-hr experiments to determine the median tolerance limits (TL/sub m/), the concentration at which 50 percent of an experimental population are dead after 96 hours for this study. The 96-hr TL/sub m/ was estimated to be 0.56 ppM. This value is much higher than the concentrations from 0.001 to 0.010 ppM found in the natural environment. Because adult oysters were used in this study, concentrations lower than 0.56 ppM may be presumed to be lethal to the more susceptible egg and larval stages. Further studies using lower salinities and pH and higher temperatures may have elicited a lower TL/sub m/ value than 0.56 ppM.

9104 Effect of a No. 2 fuel oil and a South Louisiana crude oil on the behavior of the soft shell, Mya arenaria L. Stainken, D.M. (Rutgers-The State Univ., Newark, NJ). *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 724-729(Dec 1976).

Winter temperatures were chosen because spills are more likely to occur during the inclement winter weather. The oils were added in an emulsified form to simulate a potential naturally occurring condition. Behavioral observations were recorded during bio-assay tests. The tactile responses of the clams were examined by lightly tapping the shell with a glass stirring rod. An experimental concentration at which 50 percent of the experimental animals survived (LC_{50}) was determined during a 96 hr exposure period. At low oil concentrations (50 ppM) mucus was given off by the clam out the pedal opening and siphon. Higher oil concentrations resulted in proportionally higher mucus secretion. All effects appeared to be both time and dose related. A decrease in irritability and contractibility of the siphon was noticeable at 50 ppM. At concentrations greater than 100 ppM, the pedal opening musculature rapidly became totally relaxed and did not contract. The adductor muscles simultaneously lost the ability to contract rapidly. At concentrations greater than 400 ppM, the adductors began to relax in less than 15 to 20 sec and the animal consequently "gaped". It appeared that the anterior adductor was affected first, then the posterior. The general relaxation of the musculature (adductors, siphon, pedal aperture) occurred at all oil concentrations. The intensity varied with time and dose. At 14°C, two 96 hour LC_{50} values for No. 2 fuel were obtained. These were 475 ppM and 535 ppM.

9105 Descriptive evaluation of the effects of No. 2 fuel oil on the tissues of the soft shell clam, Mya arenaria L. Stainken, D.M. (Environmental Protection Agency, Edison, NJ). *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 730-738(Dec 1976).

Clams were exposed for 28 days at 4°C to oil initially added in an emulsified form to simulate naturally occurring conditions of chronic exposure. Radical tissue changes did not occur after this exposure. It is possible that either the very low concentration of oil present in the water column was not sufficient to alter tissue structure or the exposure time was not long enough. The hydrocarbon concentrations in the water column of each tank measured during the last 3 weeks of exposure varied from 1.52 to 0.29 ppM. The general effects of subacute oil exposure can be characterized as a depletion of glycogen and generalized leukocytosis particularly evident in the blood sinuses of the pallium and mantle membrane. Increase in vacuolization of the diverticula, stomach and intestines was also evident. The histological effects appeared to be dose dependent. The clams exposed to the initial 100 ppM oil emulsion had more frequent and noticeable histological differences from the controls.

9106 (ORNL-tr—4471) **Marine biology: a change in the copper sensitivity of larvae of the sea urchin Paracentrotus lividus.** Bougis, P.; Corre, M.C. Translated by T.W. Appich Jr. from *C. R. Hebd. Seances Acad. Sci., Ser. D;* **279**: No. 15, 1301-1303(Oct 1974). 4p. Dep. NTIS, PC A02/MF A01.

The effect of copper on the development of the spines on the body of the pluteus of the sea-urchin Paracentrotus lividus shows a major variation after egg-laying, and this variation is independent of the nature of the sea water used to obtain the larvae.

VERTEBRATES

REFER ALSO TO CITATION(S) 9007

9107 Acute toxicity of oil dispersants to marine fish larvae. Wilson, K.W. (Univ. of Aberdeen, Scotland). *Mar. Biol.;* **40**: No. 1, 65-74(25 Feb 1977).

The acute toxicities of several oil dispersants to the larvae of haddock, herring, lemon sole, pilchard, plaice and sole were examined, the type and aromatic content of the solvent being the main factors influencing the toxicity. Newer ("seond generation") dispersants had much lower toxicities. Ageing of dispersant solutions led to a decrease in toxicity, which could be related to loss of aromatic compounds from solution. Temperature and salinity had only slight influence on toxicity. Differences of susceptibility between species were less than differences at different ages within a species. The larvae of all species showed a similar susceptibility when newly hatched, and susceptibility increased throughout the yolk-sac stage. The transition period from yolk reserves to an external food supply was most critical, for once larvae had established feeding, resistance increased until metamorphosis. The dispersants appeared to act largely as physical toxins causing, initially at least, a reversible narcosis. The implications of the results are discussed in relation to the use of dispersants at sea.

9108 Respiratory response of cunners to silver. Thurberg, F.P.; Collier, R.S. (National Marine Fisheries Service, Milford, CT). *Mar. Pollut. Bull.;* **8**: No. 2, 40-41(Feb 1977).

Cunners, a common inshore teleost fish of the northeast coast of the United States, were exposed to various concentrations of silver for 96 h. At the end of this exposure period measurements of gill-tissue oxygen consumption were made. Significant respiratory depression was noted after exposure to concentrations as low as 0.12 ppM. These results are compared to those of similar studies using cadmium and mercury as the test metals.

9109 Sublethal effects of lead acetate on the Y-maze performance of albino mice (Mus musculus L.). Ogilvie, D.M. (Univ. of Western Ontario, London). *Can. J. Zool.;* **55**: No. 5, 771-775(1977).

To determine if lead exposure could impair learning ability, the swimming performance of albino mice in a double Y maze was studied after 2 weeks of treatment with a 10-mg/ml drinking solution of lead acetate. This dose was sublethal and although it depressed weight gain, no overt symptoms of toxicity were observed. Lead-treated mice swam the maze significantly slower than the controls, and 40% of these animals were unable to perform to criterion, apparently because of a lead-induced impairment of locomotor ability. The lead-treated animals which did reach criterion required slightly more trials to do so than the controls, and they made significantly more errors. This finding suggests that the lead may have interfered with learning per se, in addition to causing a motor disability.

9110 Influence of cadmium on calcium transfer through the duodenal wall in rats. Gruden, N. (Inst. for Medical Research and Occupational Hygiene, Zagreb). *Arch. Toxikol.;* **37**: No. 2, 149-154(1977).

Five-week-old female albino rats were given different doses of cadmium chloride by gastric intubation daily for 1 (or 2) weeks. They were killed on 8th (or 15th) day of the experiment. Calcium-45 was used as marker to assess calcium transfer through and its retention in the duodenal wall by the everted gut sac method of Wilson and Wiseman. In all animals liver, kidney and femur wet weight were also determined. There was no significant difference in any of the parameters between rats receiving no cadmium and those who daily received 0.002 or 0.02 mg cadmium. Significantly increased calcium transfer was observed in rats given daily 0.2 mg of cadmium. A daily dose of 2.0 mg cadmium significantly decreased calcium transfer, an effect which was independent of whether the rats were killed on 8th or 15th day of the experiment. The same effect, with a significantly decreased uptake of ^{45}Ca in the duodenal wall and heavier liver was a result of administration of 15 mg of cadmium (divided in two doses). Kidneys and femurs were lighter after 7 days of treatment with 2.0 mg of cadmium, but the same cadmium dose over a fortnight produced a significant increase in the weight of kidneys. The results are discussed in the light of direct cadmium-induced membrane alterations and those which are due to inhibited activation of vitamin D.

9111 Biochemical and morphological changes in some organs of rats in nickel intoxication. Mathur, A.K.; Chandra, S.V.; Behari, J.; Tandon, S.K. (Industrial Toxicology Research Centre, Lucknow, India). *Arch. Toxikol.;* **37**: No. 2, 159-164(1977).

Biochemical and histological alterations in liver, kidney, testis and myocardium of albino rats were investigated at various intervals after daily administration of nickel sulfate. No significant changes were observed during the initial periods of the treatment, but longer exposures produced marked enzymatic and histopathological alterations in all the four organs examined. The severity of the histological lesions was found to be directly related to the duration of the treatment.

9112 Chronic copper poisoning in sheep. III. The distribution of soluble copper- and zinc-binding liver proteins of lambs compared with adult sheep. Soli, N.E.; Froslie, A.; Norheim, G. (Veterinary Coll. of Norway, Oslo). *Acta Pharmacol. Toxicol.;* **40**: No. 5, 570-574(1977).

The distribution of copper and zinc among soluble hepatic proteins in lambs from one normal and one copper dosed ewe was studied by gel filtration. It was found that the distribution pattern is similar in newborn lambs and their dams. The amount of copper in the liver indicated that a placental transfer and accumulation of copper is possible in lambs.

9113 Effect of manganese on neonatal rat: manganese concentration and enzymatic alterations in brain. Seth, P.K.; Husain, R.; Mushtaq, M.; Chandra, S.V. (Industrial Toxicology Research Centre, Lucknow, India). *Acta Pharmacol. Toxicol.;* **40**: No. 5, 553-560(1977).

Suckling rats were exposed for 15 and 30 days to manganese through the milk of nursing dams receiving 15 mg $MnCl_2.4H_2O$/kg/day orally and after which the neurological manifestations of metal poisoning were studied. No significant differences in the growth rate, developmental landmarks and walking movements were observed between the control and manganese-exposed pups. The metal concentration was significantly increased in the brain of manganese-fed pups at 15 days and exhibited a further three-fold increase over the control, at 30 days. The accumulation of the metal in the brain of manganese-exposed nursing dams was comparatively much less. A significant decrease in succinic dehydrogenase, adenosine triphosphatase, adenosine deaminase, acetylcholine esterase and an increase in monoamine oxidase activity was observed in the brain of experimental pups and dams. The results suggest that the developing brain may also be susceptible to manganese.

9114 Effects of lead nitrate ingestion on open-field behavior of mallard ducklings. Frederick, R.B. *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 739-742(Dec 1976).

Mallard ducklings were fed a control diet or a diet containing 5, 50, or 500 ppM lead as lead nitrate, ad libitum, and their open-field behavior was tested after either 3 or 8 days on treatments. Differences in open-field performances among treatments were not significant. Percentage weight gain differed significantly among treatment groups over an 8 day period, with the least growth occurring in the 5 ppM treatment group.

MAN

REFER ALSO TO CITATION(S) 7859, 9009

9115 (AD-A—040542) **Toxic hazards tests for vehicles and other equipment. Final report.** (Army Test and Evaluation Command, Aberdeen Proving Ground, Md. (USA)). 17 Jan 1977. 26p. (TOP—2-2-614). NTIS PC A03/MF A01.

This report provides test operating procedures for measuring carbon monoxide and other toxic gas concentrations produced during the operation of military vehicles and accessories, including the firing of armament. It includes measurements in work areas where engines and engine-driven equipment are operated, and describes equipment and instrumentation, standards for exposure limits, and physiological effects of exposures. It includes measurements of gases during: vehicle tests with engines and other fuel-burning accessories operating, firing tests of vehicle-mounted weapons, firing tests of vehicular weapons in test chambers, and operation of miscellaneous engine-driven equipment such as generators and compressors.

9116 Determination of cadmium in human milk during lactation. Schulte-Loebbert, F.J. (Univ., Muenster, Ger.); Bohn, G. *Arch. Toxikol.;* **37**: No. 2, 155-157(1977).

During lactation,, Cd-levels in human milk were determined by means of flameless atomic absorption spectrophotometry. The levels in colostrum were some 50 to 65% higher than in transitional and mature milk.

9117 Trace metals in teeth at birth: 1957—1963 and 1972—1973. Stack, M.V.; Burkitt, A.J.; Nickless, G. *Bull. Environ. Contam. Toxicol.;* **16**: No. 6, 764-766(Dec 1976).

Analyses of nickel, zinc, cadmium, manganese, iron, copper and lead was made on "stored" (1957 to 1963) and "recent" (1972 to 1973) specimens of partly formed teeth dissected at autopsy. An apparent increase in lead concentration by about 20 percent in a mineralizing tissue during half a generation was demonstrated. A similar increase in nickel concentration was consistent with data from other biological samples collected in the region, but the trends for other metals were not significant.

9118 Avascular necrosis of the femoral head with combination therapy. Sweet, D.L. Jr.; Roth, D.G.; Desser, R.K.; Miller, J.B.; Ultmann, J.E. (Univ. of Chicago). *Ann. Intern. Med.;* **85**: No. 1, 67-68(Jul 1976).

Four patients with malignant lymphoma who were treated with multiple courses of combination chemotherapy, consisting of cyclophosphamide, Oncovin, procarbazine, and prednisone (COPP), developed avascular necrosis of the femoral head(s). Disorders usually associated with the development of avascular necrosis were absent. The total prednisone dose received by each patient was small. Avascular necrosis of the femoral head should be considered in the differential diagnosis of bone pain in patients receiving multiple courses of combination chemotherapy.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 8113, 8995, 8999

9119 (AD-A—040146) **Eye-safe training sensor. Final technical report.** (Lockheed Missiles and Space Co., Sunnyvale, Calif. (USA). Research and Development Div.). Mar 1977. Contract DAAK70-76-C-0256. 33p. (LMSC-D—461196). NTIS PC A03/MF A01.

High-power, Class 4 lasers are utilized on the Aquila mini-RPV program to accomplish target location, artillery adjustments, and laser target designation. Lasers are classified by their capability of injuring personnel. Class 4 laser radiation is hazardous to the eye from direct beam viewing, and from specular and diffused reflections. The nominally-calculated Ocular Hazard Range for the Aquila YAG laser is 20 Km. This is only nominal, as the use of optical viewing instruments, within the beam, will extend this hazard distance considerably. Also, because of atmospheric effects upon the beam, calculation of a single Hazard Range for safety purposes is not feasible. LMSC proposed to design and build an eye-safe, Class 1,

low-power, GaAs ranging laser. This laser would be compatible with the Aquila Phase 3, 4/5 sensor platforms and could be directly substituted for the high power YAG laser on the Phase 4/5 sensor platform. The eye-safe laser ranging unit proposed by LMSC, when used with a ground located cooperative retroreflective target, would provide the Army with an excellent training simulator for RPV laser operations.

HEALTH AND SAFETY

9120 (ORNL—5171, pp 299-359) **Emergency technology program.** Chester, C.V. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Emergency technology programs to protect human populations against the consequences of nuclear war and severe radiation accidents are reviewed. Civil defense programs in the USSR and the USA are compared and the protection afforded by various types of shelters, the relocation of populations, and the consequences of nuclear attack on the nuclear power industry are considered. Severe nuclear accidents are postulated and radiation dose estimates from radioactive effluents released are presented.

9121 (UCRL—50007-76-2) **Hazards control progress report No. 53, July—December 1976.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jul 1977. Contract W-7405-ENG-48. 56p. Dep. NTIS, PC A04/MF A01.

Continued construction of the realistic phantom for calibration of transuranic isotope lung counters is discussed. Current work includes final shaping of the torso cast, development of a technique for making foamed plastic lungs loaded with transuranic isotopes, casting of tissue-equivalent (T.E.) organs, and acquisition of rib cages for the second and third phantoms.

9122 **System for labeling and control of toxic materials in a large research facility.** Porter, W.E; Hunt, C.L. Jr.; Bolton, N.E. (Oak Ridge National Lab., TN). *Am. Ind. Hyg. Assoc. J.;* **38**: No. 1, 51-56(Jan 1977).

For large industrial and research operations, maintaining reasonable control of all toxic chemicals used in their operations can be a formidable task. A system utilizing cards has been developed which serves a dual purpose, informing the user regarding hazards of a particular material and also facilitating appropriate workplace surveillance during its use. Selected data is printed on the card. The card contains a label which the user detaches and affixes to the container. This label classifies the material according to flammability, toxicity, reactivity and special properties on a 0 through 4 hazard rating system.

GEOSCIENCES

GEOPHYSICS

VOLCANOLOGY

9123 **Episodes of Cenozoic volcanism in the circum-Pacific region.** Kennett, J.P. (Univ. of Rhode Island, Kingston); McBirney, A.R.; Thunell, R.C. *J. Volcanol. Geotherm. Res.;* **2**: No. 2, 145-163(Jul 1977).

The tempo of Cenozoic volcanism on opposite sides of the Pacific Ocean has been examined by compiling the numbers of radiometric dates reported for terrestrial volcanic sequences and the numbers of volcanic ash (glass) horizons recorded in Neogene deep-sea (DSDP) sedimentary sections. Within certain limits these data are believed to provide a reliable record of extrusive and explosive volcanism. Although terrestrial and marine records for individual regions reveal important differences in the episodicity of volcanism, a correlation is found between activity in the Southwestern Pacific, Central America and the Cascade Range of western North America. Two important pulses of Neogene volcanism (the Cascadian and Columbian episodes) occurred during the Quaternary (t = approximately 2 m.y. to present) and within the Middle Miocene (t = 16 to 14 m.y. ago), with less important episodes in the latest Miocene to Early Pliocene (t = 6 to 3 m.y. ago) and Late Miocene (11 to 8 m.y. ago). The names Fijian and Andean are proposed to these episodes. Dating of terrestrial sequences indicates that these episodes of intense volcanism took place in relatively short intervals of time, separated by longer more quiescent periods. It has been suggested that synchronous episodic volcanism is related to changes in rates of sea-floor spreading and subduction. If so, volcanism must amplify these changes, because the variations in tempo of volcanism are much too great for proportional rate changes. An apparent correlation of volcanism in orogenic zones of the circum-Pacific region with world-wide changes of sea level and changes of activity in the Hawaiian-Emperor chain suggests that volcanism records fundamental tectonic changes throughout the entire Pacific region.

9124 **Heat discharge from summit crater of Mihara Volcano, Ooshima.** Yuhara, K.; Sekioka, M. (Kyushu Univ., Fukuoka). *J. Volcanol. Geotherm. Res.;* **2**: No. 2, 187-202(Jul 1977).

Using an infrared radiation thermometer, measurements by remote sensing were carried out for surface temperatures of the bottom-floor and wall of the central pit and its surrounding crater bottom of Mihara volcano, Ooshima, Japan. Isotherms for the wall of the central pit are compared with the thermal and other surface manifestations. Heat discharge from the summit crater of Mihara volcano is estimated on the basis of various meteorological and other techniques, and for convenience of computation it is divided into the following three categories; latent and sensible heat transferred by ascending volcanic gas; heat emitted from the bottom-floor and wall of the central pit; and heat transported conductively and convectively from the underground heat source through the western, southern and eastern parts of the crater bottom. The computed heat discharge is estimated to be 1.4×10^7 cal s^{-1}, which is about one order of magnitude less than that of the minor eruption on February 28, 1974. The methodology developed here for estimation of the heat discharge from a volcano can also be applied to other volcanoes.

9125 **Rift-transform structure of the seafloor ridge system; thermal convection subject to tidal bulge formation.** Bostrom, R.C. (Univ. of Washington, Seattle). *Mod. Geol.;* **6**: No. 2, 67-74(Mar 1977).

The generation of a system consisting jointly of rifts and transforms is described. Lithosphere which can deform only by failure rests upon mantle subject to rotational flow. Rifts and transforms represent the separate expression of extension and rotational strain at plate junctions. Transforms become longer and are cumulatively offset (stair-stepped) in one direction as the contribution of rotation increases relative to the contribution of extension. The rotational flow affecting the mantle is the result of thermal buoyancy acting in conjunction with the stress imposed by passage of the tidal bulge. The stress imposed by bulge formation is comparable with the primary buoyancy stress and contributes cumulative rotational strain. In mantle maintained at yield point by convection a small fraction of the displacement in bulge formation is not recovered and appears as a bias in the circulation, acting so as to promote clockwise plate rotation in the north hemisphere. Transforms in the north hemisphere predominantly are rotated clockwise relative to the ridge axis, and vice versa, in the fashion described by Howell.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

9126 **Point load strength of some Indian rocks.** Verma, B.S. *J. Mines, Met. Fuels;* **24**: No. 8, 257-264(Aug 1976).

A facility for determining the point-load strength of rock has been established in the Rock Mechanics Laboratory of the Department of Mining Engineering, Benares Hindu University. The point-load strength and compressive strength of a number of Indian rocks, including Makrana marble, Chunar Sandstone, Dalla limestone and several Coal Measures rocks of Singrauli coalfield, were measured.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 7931, 8046, 8256, 9019

PHYSICS RESEARCH

9127 (PB—268513) **Critical evaluation of data in the physical sciences. A status report on the National Standard Reference Data System, January 1977.** Rossmassler, S.A. (National Bureau of Standards, Washington, D.C. (USA). Office of Standard Reference Data). May 1977. 88p. (NBS-TN—947). NTIS PC A05/MF A01.

This is a report on the status of the National Standard Reference Data System as of January 1977. Current activities and functions of the Office of Standard Reference Data are summarized. A complete list of data evaluation projects supported by the Office of Standard Reference Data during Fiscal Year 1977 is included; this list also includes projects which received financial support during the previous fiscal year, and which are still actively involved in some aspect of data compilation and evaluation. The list of projects includes continuing data centers in the United States whose activities fall within the scope of the system, but which are not formally affiliated with it. A list of publications resulting from the National Standard Reference Data program is provided.

ASTROPHYSICS AND COSMOLOGY

STARS

REFER ALSO TO CITATION(S) 9146

9128 (N—77-22030) **Small scale turbulence in the Crab Nebula: evidence of lower hybrid parametric instabilities driven by the pulsar wave.** Lee, L.C. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Mar 1977. 15p. (NASA-TM-X—71295; X—602-77-69). NTIS PC A02/MF A01.

Strong small scale turbulence is observed in the Crab Nebula from the temporal pulse broadening data. It is shown that the strong 30 Hz pulsar wave can parametrically excite instabilities near the lower hybrid frequency in the thermal plasma of the Crab Nebula with a characteristic wavelength of the order of the scale size a of the turbulence observed. These instabilities provided a coupling mechanism between the pulsar wave and the Nebula plasma.

9129 **Distinguishing between stars and galaxies composed of matter and antimatter using photon helicity detection.** Cramer, J.G.; Braithwaite, W.J. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev. Lett.;* **39**: No. 17, 1104-1107(24 Oct 1977).

The positrons produced in fusion processes in matter stars will have predominantly a "right" helicity due to the nonconversation of parity in weak interactions. This helicity is transferred to bremsstarhlung and forward in-flight annihilation radiation, which will be right-circularly polarized. In antimatter stars, CP symmetry will make the equivalent radiation left-circularly polarized. The helicity of such radiation can be used to distinguish between astronomical objects composed of matter and antimatter.

9130 **Neutron capture by ^{208}Pb at stellar temperatures.** Macklin, R.L.; Halperin, J.; Winters, R.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee). *Astrophys. J.;* **217**: No. 1, 222-226(1 Oct 1977).

Neutron capture cross section data for isotopically enriched ^{208}Pb were taken at the Oak Ridge electron linear accelerator time-of-flight facility and analyzed for nuclear resonance capture parameters up to 825 keV. Two new capture resonances at energies (43.29 and 47.26 keV) near stellar interior temperatures were found. The resonance parameter data lead to improved values for ^{208}Pb neutron capture probabilities calculated for a wide range of stellar interior temperatures.

9131 **Potential drops above pulsar polar caps: acceleration of nonneutral beams from the stellar surface.** Fawley, W.M.; Arons, J.; Scharlemann, E.T. (Department of Astronomy, University of California, Berkeley). *Astrophys. J.;* **217**: No. 1, 227-243(1 Oct 1977).

We develop a self-consistent, three-dimensional method for the calculation of the steady-state acceleration of nonneutral plasma at the surface of a rotating, magnetized, isolated neutron star. When the effects of surface work functions are negligible, there is a unique monotonic electrostatic potential and associated current profile. We obtain explicit solutions in the monopole and polar-cap geometries. In the latter, we neglect field-line curvature and consider only the aligned rotator. The maximum asymptotic particle energy in the polar-cap case, achieved along the central field line, is found to be E/sub max/=2.8 x 10^{9} eV x (P/1 s)$^{-1}$(B/10^{12} gauss)/sup 1/2/(R/sub asterisk6/ cm)/sup 1/2/(Zm/m/sub e/)/sup 1/2/. This result is in good accord with previous estimates made by Michel. The total luminosity of the pulsar in the form of each charged-particle beam from a polar cap is L/sub cap/=4 x 10^{27}(P/1 s)$^{-3}$(B/10^{12} gauss)/sup 3/2/ (R/sub asterisk6/ cm)/sup 9/2/(m/Zm/sub e/)/sup 1/2/ ergs s^{-1}. This luminosity is sufficient to explain radio pulsars if the beam energy can be converted to radio radiation with reasonably high efficiency, but is insufficient to explain pulsed γ-ray emission from the Crab and other pulsars. In these numerical estimates, we assume that the closed magnetosphere extends to the light cylinder. We also investigate the rotation rate of the plasma, and show that on the open-field lines of the aligned rotator, the beam current induces a twist to the field lines such that an observer at infinity sees the plasma as nonrotating. We apply these results and point out the necessity of including the effects of field-line curvature in a realistic model.

9132 **Hydrogen emission lines in long-period variables.** Bychkov, K.V.; Panchuk, V.E. (Special Astrophysical Observatory, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 189-196(Mar 1977).

The known models of the formation of emission lines in long-period variables of the Mira Ceti type are discussed: emission behind a shock-wave front and heating of the chromosphere by the dissipation of acoustic and magnetohydrodynamic waves. The difficulties of the model of the emergence of a shock wave into the atmosphere are the following: one cannot explain the fact of the slow fading of bright lines following the brightness maximum due to rapid cooling in free—free transitions; the amount of outflow is found to be an order of magnitude greater than the generally accepted value; the connection with emission in red giants, whose brightness varies relatively little, is not clear. The hypothesis of heating of the chromosphere by waves generated below the photosphere is not applicable to Mira-type stars, since such waves must be already damped in cool layers. A model is proposed according to which the emission lines are radiated by hot spots formed by the reconnection of oppositely directed magnetic fields in regions above the photosphere (by analogy with solar flares). Within its framework one can explain the absolute intensity of the emission lines and their variability with characteristic times on the order of several days. With a sufficiently powerful flare a brightness fluctuation synchronous with the variation in the emission spectrum is possible; such a possibility is excluded under the assumption of a homogeneous chromosphere.

9133 **Physical statement of the problem of the thermonuclear explosion of a degenerate carbon stellar core.** Ivanova, L.N.; Imshennik, V.S.; Chechetkin, V.M. (Institute of Applied Mathematics, Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 197-204(Mar 1977).

The formation of a degenerate carbon stellar core is characteristic of the late stages of evolution of main-sequence stars wih masses of 3.5 M/sub sun less-thanM/M/sub sun/Following the ignition of the carbon in this core a thermonuclear explosion is possible instead of burning in hydrostatic equilibrium. A physical statement of the problem of such an explosion is given in the report, including the hydrodynamics, the kinetics of the nuclear reactions and beta processes, and neutrino energy losses. The kinetics of the principal reaction $C^{12}+C^{12}\rightarrow Mg^{24}+\gamma$ is accurately taken into account in the low-temperature region (T9 or $\approx$3x10^{90}K), while the approximation of statistical nuclear equilibrium is used to describe the secondary nuclear reactions in the high-temperature region (T> or $\approx$3x10^{90}K). The kinetics of the neutronization of the matter and the neutrino energy losses corresponding to it in the high-temperature region are strictly analyzed. An initial model in hydrostatic equilibrium is obtained for a degenerate carbon stellar core and the initial temperature distribution is discussed separately. Interdependence of the hydrodynamics of the explosion and the kinetics of burning (self-consistency of the model) is realized in the numerical method of solution of the problem.

9134 **Observational comparison of the relation between pulse width and period for various pulsar models.** Malov, I.F. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 250-251(Mar 1977).

The observed dependence of pulse width on period agrees best with Roberts and Sturrock's model, in which the plasma in the pulsar magnetosphere plays an important role and the radiation comes from regions close to the surface of the neutron star; Smith's model shows the least satisfactory agreement.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

9135 (N—77-25051) **Studies of transient x-ray sources with the Ariel 5 all-sky monitor. Ph.D. thesis — Maryland Univ.** Kaluzienski, L.J. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). May 1977. Contract NGR-21-002-316. 251p. (NASA-TM-X—71321; X—661-77-107). NTIS PC A12/MF A01.

The All-Sky Monitor, an imaging X-ray detector launched aboard the Ariel 5 satellite, was used to obtain detailed light curves of three new sources. Additional data essential to the determination of the characteristic luminosities, rates of occurrence (and possible recurrence), and spatial distribution of these objects was also obtained. The observations are consistent with a roughly uniform galactic disk population consisting of at least two source sub-classes, with the second group (Type 2) at least an order of magnitude less luminous and correspondingly more frequent than the first (Type 1). While both subtypes are probably unrelated to the classical optical novae (or supernovae), they are most readily interpreted within the standard mass exchange X-ray binary model, with outbursts triggered by Roche-lobe overflow (Type 1) or enhancements in the stellar wind density of the companion (Type 2), respectively.

9136 **Optical properties of the accretion disk in the HZ Herculis system.** Bisnovatyi-Kogan, G.S.; Goncharskii, A.V.; Komberg, B.V.; Cherepashchuk, A.M.; Yagola, A.G. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 133-140(Mar 1977).

Photoelectric U, B, V, R observations by various authors near primary minimum of the HZ Her system (Her X-1) are analyzed for the purpose of determining the properties of the optical object surrounding the neutron star. Observations made on 10 nights at various phases of the 35/sup d/ cycle have been used. If the body around the neutron star is assumed optically opaque, best agreement with the observations is obtained for a geometrically thin disk whose projection on the plane of the sky is an ellipse with an axial ratio k =

(4/3) cos i=0.25 and an orbital inclination i=81°. Calculations are performed for selected k and i. The results show that the integral parameters of the disk vary with the phase of the 35/sup d/ cycle. The mean temperature, total luminosity, and size of the disk have two maxima, one in the ON state (psi≅0.0—0.3) and the other near the middle of the OFF state (psi≅0.6). The brightness enhancement (the hot spike) observed near the maximum of the light curve is absent at these phases. The unique relation between the properties of the optical and x-ray emission enables one to predict the appearance of x rays near the middle of the OFF state. The bulk of the optical luminosity of the disk may be associated with reemission of the x rays. The difference between the ON and OFF states is attributable to the variability of the x-ray flux incident on the disk, an effect due to the changing width of the x-ray beam.

9137 Possible explanation for the peculiarity of the Crab Nebula pulsar. Burdyuzha, V.V. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 62-63(Mar 1977).

The distinctive all-wave radiation of the Crab Nebula pulsar may be attributable to the escape of helium from the surface layer because of the ultrastrong electric field. This pulsar is now relaxing to the state typical of other radio pulsars.

9138 Stellar wind flow around an x-ray source. Krasnobaev, K.V.; Syunyaev, R.A. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 64-66(Mar 1977).

The heating of stellar wind by the radiation of an x-ray source will generate a bow shock wave ahead of the source. A similarity solution describing the flow behind the source is given.

9139 Young pulsar envelopes as gamma-ray sources. Berezinskii, V.S.; Prilutskii, O.F. (Institute for Nuclear Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 79-81(Mar 1977).

The generation of γ rays in a dense supernova envelope around a young pulsar is considered. Such sources could be observed at distances as great as ≅15 Mpc by recording their γ rays at energies E/sub γ/> or ≅100 MeV.

9140 Origin of the soft emission component of discrete x-ray sources. Mitrofanov, I.G. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 82-84(Mar 1977).

Material accreting onto a neutron star will be accelerated and heated by its interaction with the magnetic field. A soft component may thereby develop in the radiation of discrete x-ray sources, and the retarded rotation of long-period x-ray pulsars could be explained.

SOLAR PHENOMENA

9141 (N—77-25043) **Interplanetary baseline observations of type 3 solar radio bursts.** Weber, R.R.; Fitzenreiter, R.J.; Novaco, J.C.; Fainberg, J. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Apr 1977. 22p. (NASA-TM-X—71319; X—692-77-90). NTIS PC A02/MF A01.

Simultaneous observations of type III radio bursts using spacecraft separated by several tenths of an AU were made using the solar orbiters HELIOS-A and -B. The burst beginning at 1922 UT on March 28, 1976, was located from the intersection of the source directions measured at each spacecraft, and from the burst arrival time differences. Wide-baseline observations give the radial distance of the source at each observing frequency. Consequently, coronal electron densities and exciter velocity were determined directly, without the need to assume a density model as is done with single spacecraft observations. The separation of HELIOS-A and -B also provided the first measurements of burst directivity at low frequencies. For the March 28 burst, the intensity observed from near the source longitude (HELIOS-B) was significantly greater than from 60 W of the source (HELIOS-A).

9142 (N—77-25045) **Laboratory simulation of erosion by space plasma.** Kristoferson, L.; Fredga, K. (SEE ALSO- 6140550 Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). Apr 1976. 33p. (TRITA-EPP—76-06). NTIS PC A03/MF A01.

A laboratory experiment was made in which a plasma stream collides with targets made of different materials of cosmic interest. The experiment can be viewed as a process simulation of the solar wind particle interaction with solid surfaces in space, e.g. cometary dust. Special interest is given to sputtering of OH and Na. It is shown that the erosion of solid particles in interplanetary space at large heliocentric distances is most likely dominated by sputtering and by sublimation near the sun. The heliocentric distance of the limit between the two regions is determined mainly by the material properties of the eroded surface, e.g. heat of sublimation and sputtering yield, a typical distance being 0.5 a.u. It is concluded that the observations of Na in comets at large solar distances, in some cases also near the sun, is most likely to be explained by solar wind sputtering.

9143 Formation of OI resonance triplet lines in the solar spectrum. Nagirner, D.I.; Shneivais, A.B. (Astronomical Observatory of Leningrad State University). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 204-207(Mar 1977).

The OI emission resonance triplet (1302, 1304, 1306 A) in the solar spectrum is studied on the basis of the theory of the formation of a resonance multiplet. It is assumed that the population distribution of atoms over the sublevels of the lower (ground) state is a Boltzmann distribution, scattering is conservative and takes place with complete frequency redistribution of the radiation within each line, the coefficients of absorption in the lines are Doppler coefficients, and the atmosphere is semiinfinite. Using an H-function calculated earlier for primary sources which decrease exponentially with depth, profiles of the triplet lines are constructed and the total intensities and fluxes are found. A comparison with calculations for rectangular line profiles showed that the frequency redistribution is important. The results are in satisfactory agreement with observations.

9144 Opportunities for observing preflare current sheets on the sun. Syrovatskii, S.I. (Lebedev Physics Institue, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 69-71(Mar 1977).

Several possible methods are outlined for searching for current sheets on the sun ahead of time in an effort to forecast the likelihood of a solar flare, its total energy, and its power. Information on current sheets can be gathered by magnetic measurements and by observations in ultraviolet lines and in the microwave range.

9145 Propagation of nonrelativistic electrons in the solar wind, and type III radio bursts. Kurt, V.G.; Mishin, E.V.; Pisarenko, N.F. (Scientific Research Institute of Nuclear Physics, Moscow University). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 88-91(Mar 1977).

The two-component structure of electron streams with energies of tens of keV generated in solar flares, as discovered by experiments with the Prognoz satellites, is attributable to interaction of the particle streams with plasma oscillations excited in the interplanetary medium. The likelihood of stabilization of an electron beam through suppression of relaxation by induced scattering processes is estimated.

GALAXIES

9146 (N—77-21516) **Measurements of far-ultraviolet photographs from Skylab 4 and Apollo 6. Final report.** Page, T. (Naval Research Lab., Washington, D.C. (USA)). 8 Mar 1977. 5p. (NASA-CR—151242). NTIS PC A02/MF A01.

Over 700 far UV photos were obtained with the S201 electrographic camera on Skylab 4 (27 Nov. 1973 - 28 Jan. 1974) and from the Apollo-16 lunar site (21 - 23 Apr. 1972). The Lyman-alpha geocorona was found to fit R. R. Meier's model, and the tropical airglow belts were measured quantitatively. The history of Comet Kohoutek's Ly-alpha halo (and lack of an oxygen halo) was followed from 32 days before to 13 days after perihelion passage, and fitted to a model of hydrogen production from the comet. Far UV emissions from the Large Magellanic Cloud were also measured quantitatively and compared with ground-based measurements of stellar associations and nebulae. Computer programs were developed to contour the densities measured by microphotometer on the original film and to locate and sum density-volumes in each starlike image. In addition, thousands of stars were identified and their far UV flux measured in two band-passes (1050 - 1600 A, 1250 - 1600 A).

9147 (N—77-22039) **The galactic halo question: new size constraints from galactic gamma-ray data.** Stecker, F.W.; Jones, F.C. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Mar 1977. 41p. (NASA-TM-X—71281; X—602-77-73). NTIS PC A03/MF A01.

The SAS-2 gamma-ray data are analyzed with use of recent CO line emission and other data for determining the large-scale distribution of galactic gas. A nonuniform distribution of cosmic rays in the galaxy is implied. This fact rules out large trapping halo models and extragalactic origin models. Detailed models of diffusion halos of various sizes perpendicular to the galactic plane are considered. In such models, the scale perpendicular to the plane has a strong effect in determining the radial distribution of cosmic rays. Such radial distributions are calculated for cylindrical coordinate models. The implied gamma-ray longitude distributions are then calculated and compared with the SAS-2 data for goodness-of-fit. If the sources are supernova remnants or pulsars, cosmic ray nucleon halo models with scale heights greater than 3 kpc are found to provide a poor fit to the gamma-ray longitude data (probability of 6% or less). Thin halo, or source dominated diffusion models are found to provide a good fit to the gamma-ray data, with an upper limit scale height of approximately 3 kpc.

9148 **Galactic magnetic field.** Spoelstra, T.A.T. (Netherlands Foundation for Radioastronomy, Sterrewacht, Huygens Laboratory, Leiden, The Netherlands). *Sov. Phys. - Usp. (Engl. Transl.);* **20**: No. 4, 336-342(Apr 1977).

Estimates for the scale, geometry and strength of the magnetic field in the galactic system can be derived from observations of polarization properties of radio emission from the Galaxy, extragalactic radio sources and pulsars, and polarization of starlight. Within distances of about 500 parsecs (1 parsec=3.26 lightyears) from the solar system the magnetic field is directed towards galactic longitude $l \approx 45^0$, while at distances extending over a few kiloparsec its average direction is towards $l \approx 90^0$. Seen on a large scale the magnetic field in the Galaxy may be directed parallel to the galactic plane and along the spiral arms. The field may consist of a regular component and a random component with small scale variations of about 50 parsec in size. The strength of both components is of the same order of magnitude, about 2×10^{-6} Gauss (this is about 6×10^{-6} times the magnetic field strength of the earth).

9149 **Quasiclassical analysis of hydrogen radio recombination lines in H II nebulae.** Sholin, G.V.; Gulyaev, S.A. (Kurchatov Institute of Atomic Energy). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 166-169(Mar 1977).

In radiative transitions between very high levels ($n \approx 100$, $\Delta n \approx 1$), the hydrogen atom should behave like a classical system. An analysis is given of the effect of the classical properties of the atom upon the magnitude and sign of the line absorption coefficient. If n is high enough, stimulated emission in the lines will begin to predominate over the absorption, and the laser effect will arise. This phenomenon may afford an explanation of the disparity between Stark broadening theory and the observations, which show anomalously narrow lines.

9150 **Coagulation of interstellar dust grains.** Kessel'man, V.S. *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 169-174(Mar 1977).

The coagulation process is examined for interstellar grains undergoing thermal collisions, where the velocity distribution of the particles is determined by their interaction with the ambient gas (a Maxwellian distribution). The coagulation equation is solved for charged grains in the presence of the interstellar magnetic field.

9151 **Spectrum of inhomogeneities of the interplanetary plasma.** Lotova, N.A.; Chashei, I.V. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *Sov. Astron. AJ (Engl. Transl.);* **21**: No. 2, 224-227(Mar 1977).

The problem of the form of the spectrum of inhomogeneities of the interplanetary plasma is analyzed with allowance for new data. It is shown that at least two different modes of turbulence occur in the interplanetary medium: a mode of large-scale inhomogeneities, $q < 10^{-2}$ km^{-1} (10^6 km$>a>10^2$ km), with which fluctuations in the density of the proton component are connected, and a mode of small-scale inhomogeneities, $q > 10^{-2}$ km^{-1}, with which fluctuations in the electron concentration are connected.

9152 **Observable consequences of the evaporation of low-mass primordial black holes.** Vainer, B.V.; Nasel'skii, P.D. (Rostov University). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 76-78(Mar 1977).

The synthesis of light elements in a big-bang model universe is calculated for the case where primordial black holes in the mass range $3 \times 10^9 < M < 10^{12}$ g are present. Limits are placed on the density distribution of these black holes, and possible observational consequences of their existence are discussed.

9153 **Statistical properties of star populations: Evidence for active phases in the evolution of the Galaxy.** Suchkov, A.A. (Scientific Research Institute of Physics, Rostov University). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 2, 86-88(Mar 1977).

The distribution curves of galactic halo stars with respect to orbital eccentricity and angular momentum each have to dips, implying that star formation was twice inhibited during the collapse of the early Galaxy. Comparison of these dips with those found in the distribution of stars and globular clusters with respect to metal abundance indicates that bursts of activity in the early evolution of the Galxy were responsible for the creation of heavy elements and for suppressing star formation.

COSMOLOGY

9154 **Detection of anisotropy in the cosmic blackbody radiation.** Smoot, G.F.; Gorenstein, M.V.; Muller, R.A. (Lawrence Berkeley Laboratory and Space Sciences Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **39**: No. 14, 898-901(3 Oct 1977).

We have detected anisotropy in the cosmic blackbody radiation with a 33-GHz (0.9 cm) twin-antenna Dicke radiometer flown to an altitude of 20 km aborad a U-2 aircraft. In data distributed over two-thirds of the northern hemisphere, we observed an anisotropy which is well fitted by a first-order spherical harmonic with an amplitude of $(3.5 \pm 0.6) \times 10^{-3}$ °K, and direction [11.0 +- 0.6 h right ascension (R.A.) and 6° +- 10° declination (dec)]. This observation is readily interpreted as due to motion of the earth relative to the radiation with a veliocity of 390 +- 60 km/sec.

9155 **Gravitational waves in the cosmos and the laboratory.** Grishchuk, L.P. (P. K. Shternberg State Astronomical Institute (Moscow State University), Moscow). *Sov. Phys. - Usp. (Engl. Transl.);* **20**: No. 4, 319-334(Apr 1977).

Fundamental questions of the theory of gravitational waves are considered, and the properties of these waves are compared with those of electromagnetic waves. The efficiency of possible sources of gravitational radiation, both astronomical and in the laboratory, is analyzed. The principles on which detecting devices work are explained and their sensitivities are estimated. Particular attention is devoted to a new direction: the emission and detection of gravitational waves by means of electromagnetic systems. One of the variants of a laboratory experiment including a source and detector of electromagnetic type is described. The mechanism by which an isotropic blackbody background radiation of gravitons could have been formed is discussed, together with possibilities for detecting it.

9156 **Physical and astrophysical constants and their dimensional and dimensionless combinations.** Muradyan, R.M. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 73-79(Jan 1977).

A review of the fundamental physical and astrophysical constants and their dimensional and dimensionless combinations is given.

9157 **Viscosity effects in isotropic cosmologies.** Belinskii, V.A.; Khalatnikov, I.M. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 1-9(Jan 1977).

Some new types of evolution that arise in isotropic Friedmann cosmological models when allowance is made for bulk viscosity are described. The coefficient of viscosity is assumed to be a function of the energy density. For small and large values of its argument, this function is assumed to have a power-law behavior.

PLANETARY PHENOMENA

9158 (N—77-22022) **A versatile detector system to measure the charge states, mass compositions and energy spectra of interplanetary and magnetosphere ions.** Gloeckler, G. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1977. Contracts NGR-21-002-224;NGR-21-002-316. 41p. (NASA-CR—152738). NTIS PC A03/MF A01.

An instrument is described for measuring the mass and charge state composition as well as the energy spectra and angular distributions of 0.5 to 350 keV/charge ions in interplanetary space and in magnetospheres of planets such as Jupiter and earth. Electrostatic deflection combined with a time-of-flight and energy measurement allows three-parameter analysis of output signals from which the mass, charge states, and energy are determined. Post-acceleration by 30 kV extends the energy range of the detector system into the solar wind and magnetosphere plasma regime. Isotopes of H and He are easily resolved as are individual elements up to Ne and the dominant elements up to and including Fe. This instrument has an extremely large dynamic range in intensity and is sensitive to rare elements even in the presence of high intensity radiation, and is adapted for interplanetary, deep-space, and out-of-the-ecliptic missions, as well as for flights on spacecraft orbiting Jupiter and earth.

9159 (N—77-22035) **Measurements of radon concentrations in the lunar atmosphere.** Brodzinski, R.L.; Jackson, P.O.; Langford, J.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 31 Mar 1977. Contract NAS9-13268. 17p. (NASA-CR—151327; BN-SA—723). NTIS PC A02/MF A01.

The radon concentrations in the lunar atmosphere were determined by measuring the Po-210 progeny activity in artifacts returned from the moon. Experiments performed on a section of the polished aluminum strut from Surveyor 3 and data obtained from the Apollo 16 Cosmic Ray Detector Experiment Teflon thermal shield are compared with other values of the lunar radon concentration obtained at different times and different locations and by various techniques. Possible sources and release mechanisms compatible with all of the data are discussed. An experimental procedure to determine the relative retention coefficients of various types of material for radon progeny in a simulated lunar environment is described. The results of several experiments are given, and their effect on lunar radon progeny measurements is discussed. An analytical procedure is given for the analysis of a Teflon matrix for trace constituents.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

9160 (N—77-24683) **Midlatitude sporadic-E layers.** Miller, K.L.; Smith, L.G. (Illinois Univ., Urbana (USA). Aeronomy Lab.). 1 Dec 1976. Contracts NGR-14-005-181;NSF ATM-75-15523. 257p. (NASA-CR—153057). NTIS PC A12/MF A01.

The partially transparent echo from midlatitude sporadic E layers was recorded by ionosondes between the blanketing frequency and the maximum frequency. The theory that the midlatitude sporadic E layers are not uniform in the horizontal plane but contain localized regions of high electron density was evaluated using data obtained by incoherent scatter radar and found to provide a satisfactory explanation. The main features of midlatitude sporadic E layers are consistent with the convergence of metallic ions as described by the wind shear theory applied to gravity waves and tides. The interference of gravity waves with other gravity waves and tides can be recognized in the altitudes of occurrence and the structure of the layers. Small scale horizontal irregularities are attributed in some cases to critical level effects and in others to fluid instabilities. The convergence of a meteor trail can, under some circumstances, account for localized enhancement of the electron density in the layer.

9161 (N—77-24694) **Studies of auroral infrasonic substorms.** Westin, H. (Kiruna Geofysiska Inst. (Sweden)). Oct 1976. Contract NSF GA-41918. 48p. (KGI—76-3). NTIS PC A03/MF A01.

During polar magnetic substorms, 300 auroral infrasonic waves (AIW) were detected in Kiruna during an observing period of 21 months. These AIW have a mean period of 41 s and a mean amplitude of 4.1 microbar. The average horizontal trace velocity is 516 m/s with 78% of the AIW velocities between 350 m/s and 650 m/s, which corresponds to elevation angles between 25 deg and 60 deg. The AIW consist of a dispersed wave packet with a duration of just a few cycles. Their characteristics indicate that they are produced by supersonic electrojets which are coupled to the neutral atmosphere by the Lorentz force and Joule heating. The auroral sources have been identified on all sky camera pictures and on latitude diagrams of perturbations of the vertical component of the geomagnetic field. The AIW are associated with supersonic electrojets moving southward, eastward, or westward, but AIW have never been observed in connection with the poleward motion of an electrojet.

9162 (N—77-24915) **Elastic scattering of Li^+ on He and Ar, and inelastic scattering of H^+ and H_2 at low energies. Ph.D. thesis—Goettingen Univ., West Ger.** Rudolph, K. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen (Germany, F.R.)). Jul 1976. 160p. (MPIS—8/1976). NTIS PC A08/MF A01.

Measurements of elastic differential scattering cross sections of the atom-ion/atom systems Li^+ —He and Li^+ —Ar in the energy range from 1.5 to 2.55 eV are reported. Inelastic differential scattering cross sections were also measured for the system H^+ —H_2 at centers of gravity energies of 3.7 eV and 7 eV, by using the time-of-flight method.

MAGNETOSPHERIC PHENOMENA

9163 (N—77-21766) **Study of the relation between PC 3 micropulsations and magnetosheath fluctuations and of the multisatellite, multimeasurement investigation of the earth's bow shock. Space Sciences Dept.** (TRW Defense and Space Systems Group, Redondo Beach, Calif. (USA)). 30 Dec 1976. Contract NASW-2877. 60p. (NASA-CR—152646; REPT—29506-6004-RU-00). NTIS PC A04/MF A01.

The structure and direction of bow shock waves and the occurence of Pc 3, 4 micropulsations were investigated. An observational description is given of a quasi-parallel structure in a plasma parameter regime. The use of approximation to estimate the thickness of thin, nearly perpendicular bow shocks at supralaminar Mach numbers is discussed. The pattern of energies of backstreaming protons in the foreshock are predicted.

9164 (N—77-24687) **Magnetosheath electrostatic turbulence.** Rodriquez, P. (National Aeronautics and Space Administration, Greenbelt, Md. (USA). Goddard Space Flight Center). Feb 1977. 55p. (NASA-TM-X—71314; X—695-77-30). NTIS PC A04/MF A01.

The spectrum of electrostatic plasma waves in the terrestrial magnetosheath was studied using the plasma wave experiment on the IMP-6 satellite. Electrostatic plasma wave turbulence is almost continuously present throughout the magnetosheath with broadband (20 Hz- 70 kHz) r.m.s. field intensities typically 0.01 - 1.0 millivolts/m. Peak intensities of about 1.0 millivolts/m near the electron plasma frequency (30 - 60 kHz) were detected occasionally. The components usually identified in the spectrum of magnetosheath electrostatic turbulence include a high-frequency (> or = 30 kHz) component peaking at the electron plasma frequency f/sub pe/, a low-frequency component with a broad intensity maximum below the nominal ion plasma frequency f/sub pi/ (approximately f/sub pe//43), and a less-well-defined intermediate component in the range between f/sub pi/ and f/sub pe/. The intensity distribution of magnetosheath electrostatic turbulence clearly shows that the low-frequency component is associated with the bow shock; this finding suggests that the ion heating begun at the shock continues into the downstream magnetosheath.

9165 (N—77-24684) **Generalization of the method for averaging the distribution function for particle trajectories as applied to problems of numerical modeling of conic instability of magnetospheric plasma.** Churayev, R.S.; Kolosov, B.I.; Tkhabisimov, D.K. Jun 1977. Translated from Russian report PR-297. (NASA-TT-F—17538). 28p. NTIS PC A03/MF A01.

A description of several numerical approaches to a solution of modeling conic instability of magnetospheric plasma on a computer is presented. The possibility of using an averaging algorithm for particle trajectories is established on the basis of results of a solution of the problem concerning particle movement in a magnetic field of the square well type. This permits formulation of an effective method for solving this problem as applied to actual geomagnetic fields.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

9166 (ORNL—5171, pp 202-228) **Atomic and molecular physics, physicochemical properties of biologically important structure, and high-voltage research** . Christophorou, L.G.; Allen, J.D. Anderson, V.E. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Research in atomic and molecular physics is reported. Studies included: experimental evidence for the existence of a Ramsauer-Townsend minimum in liquid methane and liquid argon; discovery of a Ramsauer-Townsend minimum in gaseous ethane and propane; motion of thermal electrons in n-alkane vapors; electron mobilities in high pressure gases; electron capture and drift in liquid media; electron attachment to molecules in dense gases; attachment of slow electrons to hexafluorobenzene; fragmentation of atmospheric halocarbons under electron impact; negative ion resonances and threshold electron excitation spectra of organic molecules; theoretical studies of negative-ion resonance states of organic molecules; kinetics of electron capture by sulfur hexafluoride in solution; interactions of slow electrons with benzene and benzene derivatives; Stokes and anti-Stokes fluorescence of 1 : 12-benzoperylene in solution; photoionization of molecules in liquid media; construction of high-voltage breakdown apparatus for gaseous insulation studies; measurements of the breakdown strengths of gaseous insulators and their relation to basic electron-collision processes; accuracy of the breakdown voltage measurements; and assembling basic data on electronegative gases of significance to breakdown. (GHT)

9167 **Molecular Rydberg states. XI. Quantum defect analogies between molecules and rare gases.** Wang, H.T.; Felps, W.S.; Findley, G.L.; Rau, A.R.P.; McGlynn, S.P. (Departments of Chemsitry and Physics, The Louisiana State University, Baton Rouge, Louisiana). *J. Chem. Phys.;* **67**: No. 9, 3940-3946(1 Nov 1977).

The s and d Rydberg series of hydrogen iodide and methyl iodide are reported. These series are assigned using analogies to the corresponding series in xenon. It is shown that a comparison between molecular spectra and pertinent atomic data provides a facile assignment technique for molecular Rydberg spectra. Using the phase amplitude method, the Rydberg data are analyzed in an attempt to provide information on the residual atomic and molecular potentials and to categorize them qualitatively as attractive/repulsive, long range/short range. It is shown that, for l> or =2, the centrifugal barrier inhibits ingress of the Rydberg electron into the core and that the molecule is effectively spherically symmetric.

9168 **Photoionization of dimeric polyatomic molecules: Proton affinities of H_2O and HF.** Ng, C.Y.; Trevor, D.J.; Tiedemann, P.W.; Ceyer, S.T.; Kronebusch, P.L.; Mahan, B.H.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **67**: No. 9, 4235-4237(1 Nov 1977).

Photoionization studies of $(H_2O)_2$ and $(HF)_2$ producing H_3O^+ and H_2F^+ yield 7.18 +- 0.08 eV (165.8 +- 1.8 kcal/mole) and 4.09 +- 0.06 eV (94.3 +- 1.4 kcal/mole) as the proton affinities of H_2O and HF, respectively. The measured ionization potential of $(H_2O)_2$, 11.21 +- 0.09 eV, along with the known ionization potential of H_2O, 12.615 +- 0.001 eV, allow the deduction of a lower bound for the dissociation energy of $(H_2O)_2$:1.58 +- 0.13 eV (36 +- 3 kcal/mole). The experiments have demonstrated that photoionization of dimers is one of the most useful general methods for the determination of proton affinities.

BEAMS AND THEIR REACTIONS

9169 (CONF-770931—1) **Computer simulation of the grazing incidence backscattering of protons from a (110) nickel surface.** Hou, M.; Robinson, M.T. (Oak Ridge National Lab., Tenn. (USA)). Aug 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

From 7. international conference on atomic collisions in solids; Moscow, F.R. Germany (19 Sep 1977).

The computer program MARLOWE was used to study the processes whereby protons are reflected from the (110) surface of a nickel crystal. The ions were incident in the (001) plane, at an angle of 7.5 degrees from the surface. Energy and angular distributions of the backscattered particles were investigated for the incident energy range 0.1 to 5 keV. The results were compared with similar ones for an amorphous target. Total reflection of the beam occurred below 1.2 keV. Focusing in the [110] semichannels was found to be energy dependent and to be strongest under total reflection conditions. The energy distributions of the reflected particles showed a complex structure which is dependent on the incident energy. This structure is interpreted in terms of detailed reflection mechanisms.

9170 **Measurements of noise on an electron beam.** Dixon, R.D. (Rockwell International, Rocky Flats Plant, Golden, Colorado 80401). *Rev. Sci. Instrum.;* **48**: No. 12, 1711-1713(Dec 1977).

A technique for observing the noise on an electron beam is presented. The technique involves calculating the Fourier line spectrum from data in the form of x-ray intensity as a function of time. The results show that noise on the beam is observable in this manner and that the noise associated with the beam parameters (voltage and current) changes as the parameters change.

9171 **Linear optics theory of ion beamlet steering.** Whealton, J.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Rev. Sci. Instrum.;* **48**: No. 11, 1428-1429(Nov 1977).

Based on the paraxial approximation, a linear optics theory which accounts for steering effects in multibeamlet ion sources is presented. For a triode accelerating structure, the steering is independent of the accel potential and is in the opposite direction to the electrode displacement. For a tetrode, the steering is dependent on the potential distribution and may be in either direction relative to the displacement. With arrangements used for best optics, in tetrodes, the beam steering may be in the opposite direction to that of triodes.

9172 **Reactions of modulated molecular beams with pyrolytic graphite IV. Water vapor.** Olander, D.R.; Acharya, T.R.; Ullman, A.Z. (Materials and Molecular Research Division of the Lawrence Berkeley Laboratory and the Department of Nuclear Engineering, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **67**: No. 8, 3549-3562(15 Oct 1977).

The reaction of water vapor with the prism plane face of anneal pyrolytic graphite was investigated by modulated molecular beam—mass spectrometry methods. The equivalent water vapor pressure of the beam was $\sim 2 \times 10^{-5}$ Torr and the graphite temperature was varied from 300 to 2500°K. The mechanism was deduced from three types of experiments: isotope exchange utilizing modulated H_2O and steady D_2O beams; measurements of the phase difference between H_2O and neon reflected from the surface from a mixed primary beam of these species; and reaction of a modulated H_2O beam to produce CO and H_2. Based upon the isotope exchange experiments chemisorption of water on graphite was found to be dissociative and reversible. Incident water molecules chemisorbed with a sticking probability of 0.15 +- 0.02 to form the complexes C—OH and C—H. Recombination of the surface complexes reverses the adsorption step and is responsible for the isotope exchange properties of the graphite surface. This process is unactivated. Reaction to produce CO and H_2 also results from collisions of the primary surface complexes, but this step has an activation energy of 170 kJ/mole. This reaction yields bound complexes tentatively identified as C—O and H—C—H, which then decompose to produce the stable reaction products. All of the above steps exhibit characteristic times on the order of milliseconds, and are therefore detectable by the modulated beam method. All surface intermediates are strongly affected by solution and diffusion in the bulk of the solid.

ATOMIC AND MOLECULAR PROPERTIES

9173 (LBL—6918) **Second-order sum- and difference-frequency generation via quadrupole transitions in atomic vapors.** Bethune, D.; Smith, R.W.; Shen, Y.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1977. Contract W-7405-ENG-48. 13p. (CONF-770645—2). Dep. NTIS, PC A02/MF A01.

From 4. Rochester conference on coherence and quantum optics; Rochester, New York, United States of America (USA) (8 Jun 1977).

The inclusion of higher-multipole terms in the interaction of light with matter allows second-order nonlinear processes to be observed in isotropic media. These processes may be useful for both generating new wavelengths of radiation and measuring atomic or molecular quadrupole transition moments otherwise hard to determine. After a brief theoretical introduction, the experimental arrangement used to observe quadrupole sum-frequency generation is shown. Generally, the characteristics of the observed output agree with those predicted: the output shows the sharp two-photon resonance expected from the expression for chi/sup (Q)/ and the expected variation with k vector mismatch. At high densities and input powers, deviations from the simple theory occur: output falls sharply because of absorption associated with D-line resonances, two-photon saturation occurs, and third-order nonlinearities and population redistribution can cause changes in the index of refraction of the vapor which defocus the pump beams and destroy the phase matching of the output radiation. Quadrupole sum-frequency generation allows a novel and accurate measurement of quadrupole transition moments; values were found for the 3s-4d transition moment of Na. The creation of an electric dipole polarization by mixing of two pump fields, one of which is coupled to a quadrupole transition, can be described by the difference frequency polarization; chi/sup (Q_1)/ = 2.1×10^{-12} esu was found for Cs. 8 figs. (RWR)

9174 (N—77-24216) **Laser fluorescence spectroscopic investigations of the $(A^1\Sigma^+ - X^1\Sigma^+)$ system of ^{7}LiD. Ph.D. thesis — Goettingen Univ., West Ger.** Ennen, G. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen (Germany, F.R.)). Sep 1976. 133p. (MPIS—15/1976). NTIS PC A07/MF A01.

The laser fluorescence spectroscopy method was used to investigate the ^{7}LiD molecule. The wavelengths and intensities of the fluorescence series were measured. New molecular constants for the X-state were determined from the wavelengths, and improved constants for the A-state were obtained from available data and a fit. Several methods for determining potential curves from molecular constants are discussed and applied to the new constants. The fluorescence line intensities were used to determine the transition probabilities.

9175 (ORNL—5171, pp 97-132) **Atomic physics and laser research.** Hurst, G.S.; Payne, M.G.; Allman, S.L. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Atomic Physics and Laser Research Energy Pathways Research: Energy transfer kinetics was studied for quenching of excited states of He, N—SF_6, Ar—N, Ar—Cl, and Ar—H_2O. Fluorescence studies were also performed on various molecule mixtures. Theory of Laser Beam Interactions with Matter: Several theories are described. Two-photon resonance ionization with pulsed lasers, laser-beam-enhanced energy transfer, Doppler-free contribution to three-photon ionization, interaction of a smooth laser pulse with a two-level system, and energy transfer between slowly moving atoms are treated. Resonance Ionization Spectroscopy (RIS) and One-Atom Detection: In RIS, an excited state would be photoionized by two-step photoabsorption from a pulsed tunable dye laser. Equipment was devised for the one-atom detection and the applications of RIS. 35 figures. (DLC)

9176 **Interaction of configurations and autoionization of highly excited states of helium.** Nikitin, S.I. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 459-461(May 1977).

Doubly excited states are considered in which one electron is excited much more strongly than the other. Formulas are obtained for the amplitudes of autoionization decay of such states with high total orbital momentum. The basic laws of decay are discussed as well as the effect of configuration mixing on this decay.

9177 **Transition probabilities of a helium atom in a constant electric field.** Demkin, V.P.; Muravev, I.I. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 464-467(May 1977).

Calculations are performed for the probabilities of singlet and triplet transitions of a helium atom in a strong constant electric field. The probability of the forbidden transitions is found to depend strongly on the intensity of the electric field. The calculated values are compared with the experimental data.

9178 **Pressure dependence of the hyperfine structure of hydrogen.** Urbanovich, S.I. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 467-469(May 1977).

Positive and negative linear shifts of the hyperfine structure of the ground state of atomic hydrogen have been obtained as functions of the nature and pressure of admixed gases. An analytic expression and a numerical value have been found for the purely quadratic shift of the hyperfine structure in systems of gases of different kinds and in systems formed by charges of opposite signs. The classes of substances having a purely quadratic shift of the hyperfine structure are indicated. An interpretation of Ramsey's experiments with a hydrogen maser is given. The agreement with the experimental data is complete.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

9179 Physics and chemistry of the μ^+ meson and muonium. Gurevich, I.I.; Ivanter, I.G.; Myasishcheva, G.G.; Nikol'skii, B.A.; Nosov, V.G.; Obukhov, Y.V.; Roganov, V.S.; Selivanov, V.I.; Smilga, V.P.; Firsov, V.G. (I. V. Kurchatov Atomic Energy Institute, Moscow). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 46-56(Jan 1977).

This review of the physics and chemistry of muonium and the μ^+ meson includes experiments on the weak interaction, investigation of the properties of solids by means of μ^+ mesons, and problems of the chemistry of the hydrogen-like atom muonium. A new phenomenon is described: the two-frequency precession of muonium, and a means is presented for determination of the contact magnetic field at the μ^+ meson in ferromagnetic materials. The theory of depolarization of μ^+ mesons in matter is presented. Results are given of chemical reactions of muonium.

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 9166

9180 Quenching of $N_2(A\ ^3\Sigma^+$/sub u/) by I_2. Mandl, A.; Ewing, J.J. (Avco Everett Research Laboratory, Inc., Everett, Massachusetts 02149). *J. Chem. Phys.;* **67**: No. 8, 3490-3494(15 Oct 1977).

Production and decay of $N_2(A\ ^3\Sigma^+$/sub u/) (v=0, 1, 2) states were monitored photoelectrically from the sensitized fluorescence of NO γ bands. These states were produced by collisional transfer from excited Xe ($1S_4$) which in turn was produced by radiative energy transfer via resonance radiation (147 nm) from a closely coupled Xe flash lamp. The rate coefficient for the deactivation of $N_2(A\ ^3\Sigma^+$/sub u/) by I_2 was measured as k/sub I/2= 6.9 +- 1.9 x 10^{-12} cm^3/sec. The deactivation by NO itself was measured as k/sub NO/=4.5 +- 0.5 x 10^{-11} cm^3/sec.

9181 Energy and angular distributions of electrons ejected in the ionization of SF_6 and TeF_6 by fast protons. Toburen, L.H.; Wilson, W.E.; Porter, L.E. (Battelle Northwest Laboratory, Richard, Washington 99352). *J. Chem. Phys.;* **67**: No. 9, 4212-4221(1 Nov 1977).

Absolute cross sections, differential in ejected electron energy and emission angle, have been measured for ionization of SF_6 and TeF_6 molecules by protons in the energy range from 0.3 to 1.8 MeV. Evidence of potential barrier effects is observed in the structure of the low-energy portion of the ejected electron energy spectra. This structure, as well as cross sections for direct ionization processes, is discussed with respect to dependence on emission angle and incident particle energy. Emission cross sections are compared to similar measurements for molecules with constituents of only low atomic number.

9182 Projectile charge-state dependence of K-shell ionization by silicon ions: A comparison of Coulomb ionization theories for direct ionization and electron capture with x-ray production data. McDaniel, F.D.; Duggan, J.L.; Basbas, G.; Miller, P.D.; Lapicki, G. (Department of Physics, North Texas State University, Denton, Texas 76203). *Phys. Rev., A;* **16**: No. 4, 1375-1378(Oct 1977).

X-ray-production cross sections measured in K-shell ionization of $_{21}Sc$, $_{22}Ti$, $_{29}Cu$, and $_{32}Ge$ by 52-MeV $^{28}{}_{14}Si$/sup [q/ projectiles with q = 7 to 14 are reported, which demonstrate, through their charge-state dependence, the validity of a recently developed electron-capture theory with a reduced binding effect. Furthermore, the data provide evidence for the applicability of the perturbed stationary-state theory of direct ionization for values of 0.44 < or = Z_1/Z_2 < or = 0.67.

9183 Generalized Coulomb-projected Born-approximation cross sections for atomic excitation by charged-particle impact. Simony, P.R.; McGuire, J.H.; Golden, J.E.; Junker, B.R. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., A;* **16**: No. 4, 1401-1406(Oct 1977).

An expression is given for the (n/sub i/,l = 0 → n/sub f/,l/ sub f/ = 0) excitation cross section in terms of a single one-dimensional integral with the aid of a transformation to prolate spheroidal coordinates. Results are given for the 1s-2s excitation of arbitrary-Z hydrogenic targets. For our choice of wave functions the cross sections are found to scale as Z^{-4} at fixed E/sub inc//Z^2. The principal difference between the Coulomb-projected Born-approximation (CPBA) and Born results is in the large-angle portion of the differential cross section. This, however, leads to CPBA and Born momentum-transfer cross sections which differ by less than 20% at high energies for 1s-2s transitions.

9184 Experimental study of electron transfer in multiply charged iron-ion collisions with atomic hydrogen. Gardner, L.D.; Bayfield, J.E.; Koch, P.M.; Kim, H.J.; Stelson, P.H. (Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). *Phys. Rev., A;* **16**: No. 4, 1415-1418(Oct 1977).

The measurement of electron-transfer cross sections σ in ion collisions with atomic hydrogen has been extended to iron ions with mass number A = 56, charges q between +4 and +13, and specific energies E/A between 27 and 290 keV/amu. The charge-state dependences of σ range from q/sup 1.5/ at lower values of q and E to q^3 for higher values of these quantities. An empirical scaling relationship is found for converting $H^+ + H$ cross sections into those for Fe/sup q/ + H. Several effects correlated with shell structure in the incident ion are observed. Our results are not explained by presently available theoretical calculations.

9185 Electron scattering from diatomic polar molecules. I. The limitations of the Born approximation. Clark, C.W. (Department of Physics, University of Chicago, Chicago, Illinois 60637). *Phys. Rev., A;* **16**: No. 4, 1419-1422(Oct 1977).

The range of applicability of the Born approximation is evaluated, and represented graphically, as a preliminary to the application of frame-transformation theory beyond this range. The contribution of all partial waves beyond a lower cutoff has been thus evaluated, and is discussed explicitly.

9186 Total elastic electron scattering cross section for N_2 between 0 and 1000 eV. Dill, D.; Dehmer, J.L. (Department of Chemistry, Boston University, Boston, Massachusetts 02215). *Phys. Rev., A;* **16**: No. 4, 1423-1431(Oct 1977).

We present the total cross section for elastic electron-nitrogen scattering for incident energies 0—1000 eV. The calculations were based on the multiple-scattering model utilizing fixed-nuclei and Slater-exchange approximations, and represent a prototype for application of this method to larger molecular targets for which it is primarily intended. We are able to reproduce the π/sub g/ shape resonance at 2.4 eV and achieve quantitative agreement with absolute measurements at high incident energies by respectively adopting two potentials whose difference is based on reduced exchange and polarization interactions for high incident energy. New insight into the dynamics of electron-molecule scattering is gained by inspecting the decomposition of the cross section into component symmetries over the entire energy range covered.

9187 Binary-encounter stopping cross sections. III. Straggling and screening. Johnson, R.E.; Gooray, A.M. (Engineering Physics Program, University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., A;* **16**: No. 4, 1432-1440(Oct 1977).

A previously developed binary-encounter model describing the slowing down of energetic heavy charged particles over a broad range of incident-particle energies is employed to calculate energy straggling as a function of target Z for incident helium and hydrogen. This model seriously overestimates the measured stopping cross sections at high incident-particle energy for helium on heavy target atoms, but appears to yield more reasonable results for energy straggling. The large results in the stopping calculation are attributed to the neglect of the distortion of the electron charge cloud during the collision. A screened interaction, based on screening in a free-electron gas, is employed to estimate the size of the effect on both the stopping and straggling results for 10-MeV incident He^{++} on target atoms 1 < or = Z_2 < or = 36, and for equilibrium-charge-state beams of hydrogen at energies 1 keV to 1 MeV on a number of targets. It was found that the neglect of distortion may result in errors equivalent to or greater than those due to the neglect of the long-range dipole interactions when estimating S, particularly at higher energies. For the straggling calculation both of these effects result in considerably smaller correction to the binary-encounter method.

9188 Coherent-state multipole moments: Source of important scattering information. Gabrielse, G.; Band, Y.B. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **39**: No. 11, 697-700(12 Sep 1977).

Coherent states are completely parametrized in terms of multipole moments and their time derivatives. For hydrogen atoms excited by electron impact, our calculations show that these parameters provide new information concerning the final-state interactions of the hydrogen atom and the projectile electron. These large final-state-interaction effects make first-order perturbation calculations inappropriate. We present calculations which properly incorporate these dynamical effects. Experiments which determine these parameters are discussed.

9189 Excitation processes and charge exchanges during slow collision of Mg^+ ions with Na, K, Rb, and Cs atoms. Zavilopulo, A.N.; Zapesochnyi, I.P.; Ksaverii, Y.A.; Panev, G.S.; Shpenik, O.B. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 472-477(May 1977).

A multifaceted investigated has been carried out to study the most prominent reactions that occur when Mg^+ ions collide with Na, K, Rb, and Cs ions. The energies of the incident ions ranged from threshold to 1000 eV. The absolute cross sections for the various processes were determined (excitation, charge exchange, and charge exchange with excitation), and the efficiency of the energy distribution among the various channels was studied.

9190 Measurement of cross sections for electron-impact excitation of atomic mercury lines. Semenova, I.V.; Smirnov, Y.M. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 477-479(May 1977).

Seventy-eight electron-impact excitation functions of atomic mercury lines were measured in the 2270—7730-A spectral region at electron energies from threshold to 400 eV. Using the literature data on the radiation lifetimes of the energy states of mercury and the oscillator strength, we determined the transition probabilities for twenty-two lines and excitation cross sections for thirteen levels of the mercury atom (the contribution of cascade transitions was determined for two of them). On the basis of the transition probabilities obtained, lifetimes were determined for three levels. The dependence of the excitation cross section on the principal quantum number of the upper level was established for six spectral series.

9191 Semiclassical approximation for inverse scattering of slow atoms. Khudyakov, S.V. (L. Ya. Karpov Scientific-Research Physicochemical Institute, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 394-395(Mar 1977).

A method is presented for calculating the central potential in atom-atom collisions that allows for the oscillatory nature of the differential cross sections. The interaction potential of Na and Hg is obtained as an example.(AIP)

9192 Two-photon positron-K-electron annihilation. Gorshkov, V.G.; Mikhailov, A.I.; Sherman, S.G. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 17-22(Jan 1977).

We evaluate the cross-section for the two-quantum positron annihilation by atomic K electrons for small αZ and arbitrary values of the momentum transfer q to the nucleus. We obtain the angular distribution of the emerging photons and various simple limiting formulae. We calculate the shift in the maximum of the line shape of the annihilation photon caused by the binding of the electron to the nucleus.

ATOMIC AND MOLECULAR THEORY

9193 Nuclear spin relaxation spectroscopy. Netzel, D.A.; Miknis, F.P. (Laramie Energy Research Center, Energy Research and Development Administration, Box 3395, University Station, Laramie, Wyoming 82071). *Appl. Spectrosc.;* **31**: No. 5, 365-386(Sep 1977).

From the time dependence of the nuclear spin relaxation phenomena, molecular structure, conformation, motions, interactions, diffusion, and adsorption can readily be studied. Aside from the studies at the molecular level, nuclear spin relaxation phenomena have been applied to qualitative and quantitative analysis in the areas of polymer research, agriculture and food research, petroleum research, and medical research. This article presents an introduction to the theory, techniques, and applications of nuclear spin spectroscopy.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 9503

9194 Structure of a liquid/vapor interface. Kalos, M.H. (New York Univ., New York); Percus, J.K.; Rao, M. *J. Stat. Phys.;* **17**: No. 3, 111-136(1977).

The structure of the interface of an argonlike fluid in equilibrium with its own vapor at low temperature is studied using molecular dynamics. The longitudinal pair correlations in the interface are found to be consistent with a simply defined ensemble of local thermodynamic states. However, the transverse correlations exhibit very long-range behavior not predicted by straightforward local thermodynamics. These results strongly suggest that the interface is made up of an ensemble of configurations in each of which the transition from liquid to vapor is locally sharp, but that the transition surface fluctuates strongly in space and time.

9195 Equilibrium state of a classical fluid of hard rods in an external field. Percus, J.K. (New York Univ., New York). *J. Stat. Phys.;* **15**: No. 6, 505-511(1976).

The external field required to produce a given density pattern is obtained explicitly for a classical fluid of hard rods. All direct correlation functions are shown to be of finite range in all pairs of variables. The one-sided factors of the pair direct correlation are also found to be of finite range.

MAGNETOHYDRODYNAMICS

9196 Boundary condition for computational magnetohydrodynamics. Lindemuth, I.R. (Lawrence Livermore Laboratory, Livermore, California 94550). *J. Comput. Phys.;* **25**: No. 2, 104-117(Oct 1977).

A new "background plasma" method for treating boundaries in Eulerian magnetohydrodynamic computations is presented. Previously unconsidered aspects of plasma confinement by a wall are examined in the formulation of the boundary condition. Innovations include a distinct condition under which a plasma can separate from a wall resulting in an influx of "background plasma," the use of boundary values which are interpreted to be interface values not included in volume integrations, and a condition under which a plasma returns to the wall resulting in a stoppage of the outflux of "background plasma." Excellent agreement is obtained between a Lagrangian computation and an Eulerian computation incorporating the new boundary condition.

SUPERFLUIDITY

9197 Ferromagneticlike resonance behavior in superfluid ^{3}He-B. Webb, R.A. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **39**: No. 16, 1008-1011(17 Oct 1977).

Nonlinear cw NMR behavior, similar to that observed on ferromagnets at high rf powers, has been observed in superfluid ^{3}He-B using a superconducting quantum interference device (SQUID) magnetometer in fields of 31, 102, 180, and 308 Oe and at a pressure of 21 bar. It is observed that beyond some threshold value of the transverse H_1 field the z component of magnetization anomalously decreases and is followed by a rapid increase back to the normal resonance curve as the frequency of the H_1 field is swept through resonance.

9198 Lagrange equations of the hydrodynamics of the anisotropic superfluid liquid He^3-A. Khalatnikov, L.M.; Lebedev, V.V. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 351-354(20 Apr 1977).

The Lagrangian formalism is used to derive equations that describe the hydrodynamics of He^3-A. The form of the conservation laws is obtained. The dissipative terms in the hydrodynamic equations are considered.

9199 Spectral features of the spontaneous scattering of light at the surface of a superfluid liquid. Bozhkov, A.I.; Kolomenskii, A.A. (P. N. Lebedev Institute of Physics, Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **3**: No. 3, 134-139(Mar 1977).

Based on Khalatnikov's two-component hydrodynamic equations and using the fluctuation-dissipation theorem, an expression is found for the spectral density of the surface fluctuations of a superfluid liquid. We shall use the hydrodynamic model of surface waves proposed by Seiden. The density of the liquid is assumed to be constant; the possibility is accepted however of an adjusted change of density of the normal (rho/sub n/) and superfluid (rho/sub s/) components, which will permit a change of entropy σ due to changes of temperature during surface fluctuations to be taken in account. Evaporation is neglected, so that together with the usual boundary conditions expressing equality to zero of the flows of mass, entropy and momentum through the surface, the condition of constancy of the chemical potential along the surface of the superfluid liquid is used. It is shown that for values of the wave vectors of surface waves, $q = 10^2$ to 10^5 cm^{-1} in the temperature range T> or $\simeq 0.9°$K, the expression found for the spectral density gives the same values as the similar expression obtained within the scope of the hydrodynamic model, in which the quantities rho/sub n/, rho/sub s/ and σ are assumed to be constant. In the temperature range 0.6°K9 or $\simeq$T9 or $\simeq 0.9°$K, the stated model gives significantly different results, and in our case narrower spectral lines are obtained, and with defined conditions in the case of weak damping of the surface waves an expression is obtained for the spectral density of the Lorentz type, in which the central frequencies of each of the two lines of the spectral doublet are found to be proportional to some combination of the viscosity coefficients eta, zeta$_1$, zeta$_2$, and zeta$_3$. This, in principle, gives the possibility of determining experimentally this combination by the spectrum of the spontaneous surface scattering of light.

HIGH ENERGY PHYSICS

9200 (ORO—3509-14) **Elementary particle physics at the Florida State University. Progress report.** (Florida State Univ., Tallahassee (USA). Dept. of Physics). Sep 1977. Contract EY-76-S-05-3509. 23p. Dep. NTIS, PC A02/MF A01.

Research on experimental and theoretical high energy physics is summarized. A list of publications is included. (JFP)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

9201 Electron-muon and electron-hadron production in e^+e^- collisions. Barbaro-Galtieri, A.; Kwan, B.P.; Litke, A.M.; Dorfan, J.M.; Ely, R.; Feldman, G.J.; Feller, J.M.; Fong, A.; Gobbi, B.; Hanson, G.; Jaros, J.A.; Lecomte, P.; Lueke, D.; Madaras, R.J.; Martin, J.F.; Mast, T.S.; Miller, D.H.; Parker, S.I.; Perl, M.L.; Peruzzi, I.; Piccolo, M.; Pun, T.P.; Rapidis, P.A.; Ronan, M.T.; Ross, R.R.; Sadoulet, B.; Trippe, T.G.; Vuillemin, V.; Yount, D.E. (Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **39**: No. 17, 1058-1061(24 Oct 1977).

We observe anomalous $e\mu$ and e-hadron events in e^+e^- collisions at SPEAR in an experiment that uses a lead-glass counter system to identify electrons. The anomalous events are observed in the two-charged-prong topology. Their properties are consistent with the production of a pair of heavy leptons in the reaction $e^+e^- \rightarrow$ tau$^+$ tau$^-$ with subsequent decays of tau^{+-} into leptons and hadrons. Under the assumption that they come only from this source, we measure the branching ratios B (tau $\rightarrow$ eν/sub e/ν/sub tau)/ = (22.4 +- 5.5) % and B (tau $\rightarrow$ h + neutrals) = (45 +- 19) %.

9202 Inclusive photoproduction of protons by bremsstrahlung of maximum energy 2.0—4.5 GeV. Alanakyan, K.V.; Amaryan, M.D.; Demirchyan, R.A.; Egiyan, K.S.; Ogandzhanyan, M.S.; Sharabyan, Y.G. (Erevan Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 292-297(Mar 1977).

The A/sup n/-dependence and momentum spectra of photoprotons in the nuclei ^{12}C, ^{27}Al, ^{63}Cu, ^{118}Sn, and ^{208}Pb have been studied experimentally for maximum bremsstrahlung energies of 2.0, 3.0, and 4.5 GeV. The A-dependence shows that the proton photoproduction mechanism for E/sub γ/MeV is identical for the entire kinetic-energy region 65—280 MeV and the angle region 45—150° for the secondary protons studied. The dependence of the exponent n on the transverse momentum p/sub transverse/is in good agreement with the same dependence for protons produced in nuclei by primary protons. In the momentum spectra of the invariant cross section f= $(E/p^2)(d^2\sigma/d\Omega dpQ) \sim \exp(-Bp^2)$ it is observed that the parameter B does not depend on the incident-photon energy and on the target nucleus, but depends on the proton-detection angle.

WEAK INTERACTIONS

9203 (COO—1545-215) **Measurement of the angular correlation parameters in the B decay of polarized Λ hyperons.** Lindquist, J.; Swallow, E.C.; Sumner, R.L.; Watson, J.M.; Winston, R.; Wolfe, D.M.; Reibel, K.; Schwartz, D.M.; Stevens, A.J.; Romanowski, T.A. (Chicago Univ., Ill. (USA). Enrico Fermi Inst.; Ohio State Univ., Columbus (USA); Argonne National Lab., Ill. (USA)). Apr 1977. Contract EY-76-C-02-1545. 36p. Dep. NTIS, PC A03/MF A01.

Final results are presented from an experimental investigation of the β decay of polarized Λ hyperons with a large-aperture magnetic spectrometer. The data sample consists of 544 events. The values A/sub ν/ = 0.72 +- 0.12, A/sub e/ = 0.05 +- 0.12, and A/sub p/ = -0.47 +- 0.12 are obtained for the three spin asymmetry parameters, and A/sub eν/ = 0.07 +- 0.12 for the electron-neutrino correlation. The lepton-plane correlation with the Λ spin, D = 0.11 +- 0.20, is consistent with no violation of time reversal invariance. The data yield an axial vector to vector form factor ratio of g_1/f_1 = 0.53/sub -0.09//sup +0.11/. The Cabibbo model value is g_1/f_1 = 0.71.

9204 (LBL—6728) **Observation of μe events in antiν and ν interactions in the Fermilab 15′ neon-H bubble chamber.** Balagh, H.C.; Bingham, H.H.; Rosetti, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 18 Aug 1977. Contract W-7405-ENG-48. 16p. (CONF-770696—1; VTL-PUB—42). Dep. NTIS, PC A02/MF A01.

From International conference on neutrino physics and neutrino astrophysics; Elbrus, USSR (18 Jun 1977).

In an exposure of the Fermilab 15′ neon (64 atomic %)—H_2 bubble chamber to a broad band anti ν beam, 3 μ^+e^-X and 6 μ^-e^+X events (with estimated backgrounds 1.1 and 0.6 events, respectively) were found with the μ/sup +-/ identified in the EMI. The fractions of μ^+e^- and μ^-e^+ production relative to anti ν/sub μ/ and ν/sub μ/ charged current interactions are respectively anti f = (0.10 +- /sub 0.07//sup 0.13/)% and f = (0.34 +- /sub 0.13//sup 0.23/)%, giving anti f/f = 0.3 +- /sub 0.2//sup 0.5/.

9205 Rate of dimuon production from neutrinos and antineutrinos at high energy. Barish, B.C.; Bartlett, J.F.; Bodek, A.; Brown, K.W.; Buchholz, D.; Chu, Y.K.; Sciulli, F.; Siskind, E.; Stutte, L.; Fisk, H.E.; Krafczyk, G.; Nease, D.; Fackler, O. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev. Lett.;* **39**: No. 16, 981-984(17 Oct 1977).

We present data on dimuon-production rates from neutrinos and antineutrinos in the energy range 45-205 GeV. The measurements were made using the Fermilab narrow-band beam. At higher energies (> or $\approx$ 100 GeV), the dimuon-production rates relative to single-muon production for events within our kinematic cuts are about 1%. The numbers are consistent with calculations of Glashow-Iliopoulos-Maiani (four-quark) models and do not require the introduction of additional quarks.

9206 Energy spectra of secondary leptons in the process $e^+ + e^- \rightarrow L^+ + L^-$. Azimov, Y.I.; Berkov, A.V.; Zhizhin, E.D.; Nikitin, Y.P.; Frankfurt, L.L.; Khoze, V.A. (Moscow Engineering-Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 335-340(Mar 1977).

Exact expressions are obtained for the energy spectra of secondary leptons e and μ from the decays of heavy leptons L^{+-} produced in the reaction $e^+ + e^- \rightarrow L^+ + L^-$. It is shown that the specific properties of these spectra make it possible to identify the reaction of heavy-lepton production in the e^+e^- annihilation process and to determine the masses of the heavy lepton L^{+-} and its neutral partner ν/sub L/(nu-bar/sub L/). Calculations are carried out under the assumption that the current (L-barν/sub L/) has a V +- A structure.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 9214, 9216

9207 (COO—2009-132) **Technical progress report of the Indiana University High Energy Physics Group, December 1, 1976—November 30, 1977.** Brabson, B.B.; Crittenden, R.R.; Dzierba, A.R.; Heinz, R.M.; Neal, H.A.; Ogren, H.O. (Indiana Univ., Bloomington (USA). Dept. of Physics). 1977. Contract EY-76-S-02-2009. 22p. Dep. NTIS, PC A02/MF A01.

Since the beginning of the ERDA contract year (Dec. 1, 1976), the Indiana High Energy Physics Group has been actively participating in experimental programs at SLAC, Fermilab, CERN, and the Argonne ZGS. The SLAC effort (E103) is a search for exotic mesons. The polarization program at Fermilab's internal target (CO) area involves polarization measurements in pp $\rightarrow$ pp (E313) and pp $\rightarrow$ pX (E522). The contribution to the Multiparticle Spectrometer at Fermilab is a major ingredient in a series of experiments (E110/260/523/557) studying low-p/sub t/ and high-p/sub t/ hadron-hadron collisions. At CERN work is carried out with a Saclay group at the SPS to investigate properties of psi meson production in experiment WAll. The Argonne ZGS endeavor (E399) is to measure various inclusive polarizations, complementing Fermilab E522 work. Also participation is given in design work on a PEP proposal. A discussion of these experiments is given.

9208 Test of scaling in muon-pair production by hadrons. Antreasyan, D.; Cronin, J.W.; Frisch, H.J.; Shochet, M.J.; Kluberg, L.; Mueller, J.J.; Piroue, P.A.; Sumner, R.L. (Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **39**: No. 15, 906-908(10 Oct 1977).

We have measured the inclusive production of massive dimuons (7 < or = M/sub mumu/GeV/c^2) by 200-, 300-, and 400-GeV protons incident on Cu in order to check whether the dimensionless cross section M/sub mumu3/[dσ/dM/sub mumu d yy-italic/=0 is a function of M/sub mumu2//s alone, where s is the square of the c.m. energy. The results support the scaling hypothesis.

9209 Measurement of phi production in proton-nucleus collisions at 400 GeV/c. Akerlof, C.W.; Alley, P.; Bintinger, D.; Ditzler, W.R.; Finley, D.A.; Johnson, O.E.; Koltick, D.; Loeffler, F.J.; Loveless, R.L.; Meyer, D.I.; Shibata, E.I.; Stanfield, K.C.; Thun, R.; Yovanovitch, D.D. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **39**: No. 14, 861-864(3 Oct 1977).

We have measured the invariant cross section for inclusive phi production in proton-nucleus collisions at 400 GeV/c near Feynman chi = 0. For transverse momenta in the range between 0.8 and 3.5 GeV/c the ratio of the phi to π^- rises from 1 to 7%. We also report on correlations with particles opposite the phi in the center-of-mass system as they relate to the Okubo-Zweig-Iizuka rule.

9210 Coherent diffractive transformation of 20.8-GeV/c protons into the $p\pi^+\pi^-$ system. Azimov, S.A.; Saidkhanov, N.S.; Chudakov, V.M. (Physico-technical Institute, Uzbek Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 305-307(Mar 1977).

A selection criterion is described for the coherent diffractive dissociation $p \rightarrow p\pi^+\pi^-$, which is based on curvature and ionization measurements and makes possible reliable identification of the secondary protons. The invariant-mass spectra of the secondary particles are compared with some theoretical models.

9211 Investigation of diffractive dissociation of 200-GeV/c protons with the aid of the parametrically invariant quantity g_1. Abduzhamilov, S.; Azimov, S.A.; Gadzhieva, S.I.; Dzhuraev, M.D.; Eroshkina, N.B.; Chudakov, V.M. (Physico-technical Institute, Uzbek

Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 307-309(Mar 1977).

The emission angles of the secondary charged particles in 4- and 5-prong stars containing not more than one strongly ionizing particle were measured in emulsion bombarded by 200-GeV/c protons. The distribution of the 4-prong stars with respect to the quasirapidity-asymmetry exponent has a characteristic peak due to the diffractive dissociation.

9212 Relative yields of 25-GeV/c K^- mesons, antiprotons, and antideuterons in interactions of 70-GeV protons with nuclei. Baldin, V.Y.; Vertogradov, L.S.; Vishnevskii, N.K.; Krumstein, Z.V.; Lapshin, V.G.; Leiste, R.; Merekov, Y.P.; Nikolaev, N.N.; Petrukhin, V.I.; Pose, D.; Ronzhin, A.I.; Rykalin, V.I.; Solyanik, V.I.; Suvorov, V.M.; Chemnitz, G.; Khovanskii, N.N.; Khomenko, B.A.; Szawlowsky, M.; Shelkov, G.A.; Schueler, J. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 316-318(Mar 1977).

Considerable statistics on antideuterons (7.6×10^4d-bar) produced by 70-GeV protons on Be, Al, Cu, and W targets have been accumulated during an experimental search for new heavy particles and antinuclei, during which the relative count rates for secondary K^- mesons and antiprotons were also measured. Here the relative yields R/sub d/, R/sub K/-, and R/sub p/ (R/sub i/ = $(d^3\sigma/sub\ i//dpd\Omega)/(d^3\sigma/sub\ \pi//dpd\Omega)$ are derived from these data.

9213 A-dependence of inclusive spectra of protons with large transverse momenta in proton-nucleus collisions. Alaverdyan, G.B.; Tarasov, A.V.; Uzhinskii, U.V. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 354-355(Mar 1977).

The experimental data on the cross sections of the reaction pA→pX at large values of the transverse momentum transfer (p/sub transverse/GeV/c) are analyzed within the framework of the theory of multiple scattering.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 9207

9214 (LA—6962-T) Charged pion production from neutron—proton collisions at 790 MeV. Thomas, W.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36;EY-76-S-04-3347. 135p. Dep. NTIS, PC A07/MF A01.

The two reactions $np \rightarrow nn\pi^+$ and $np \rightarrow pp\pi^-$ were studied at 790 MeV (incident neutron energy). Pion spectra were measured at 10 different angles with a multiwire proportional chamber spectrometer. Approximately 100,000 events were analyzed. The angular distribution of pions in the np center of momentum system ($d\sigma/d\Omega^*$) was given by $[(123.1 +- 2.7) + (88.3 +- 4.9)\cos^2(\theta^*)](\mu b/sr)$. The cross section $\sigma(np \rightarrow NN\pi/sup\ +-/)$ was determined to be 1.92 +- .20 mb by integrating $(d\sigma/d\Omega^*)$ over all angles. The partial cross section for pion production from T = 0 np interactions (σ_{01}) was found to be .1/sub -.1//sup +.5/ mb by using the relation $\sigma_{01} = 2\sigma(np \rightarrow NN\pi/sup\ +-) - \sigma(pp \rightarrow pp\pi^0)$. Stronger indications of nonresonant pion production were given by the presence of asymmetries between the positive and negative pion spectra and a comparison of the data with an isobar model calculation.

9215 (ORO—3065-42) Progress report, 1 September 1976—30 September 1977. (Duke Univ., Durham, N.C. (USA). Dept. of Physics). 1977. Contract EY-76-S-05-3065. 14p. Dep. NTIS, PC A02/MF A01.

Research on pion reactions with hydrogen and other nuclei is summarized. A list of publications is included. (JFP)

9216 (ORO—3948-09) Pion interactions at medium energies. Progress report, December 1, 1976—November 30, 1977. Mayes, B.W. II; Hungerford, E.V. III. (Houston Univ., Tex. (USA)). Sep 1977. Contract EY-76-S-05-3948. 45p. Dep. NTIS, PC A03/MF A01.

The activity of the University of Houston Group during the past year in experimental intermediate energy physics is covered. Research in this area is expanding rapidly throughout the world with the operation of the new meson facilities. This report summarizes research efforts at LAMPF, SREL, Brookhaven National Laboratory and Argonne National Laboratory. The main thrusts of present research is to understand pion production in the few nucleon system, and to begin a series of experiments using K mesons as a probe of the nucleus. Work involving the difference between $\pi/sup\ +-/$ forward scattering from ^{40}Ca and ^{48}Ca along with proton-proton and proton-deuteron scattering, will also be reported.

9217 Elastic backward scattering of negative pions by protons at 25 and 38 GeV/c. Babaev, A.I.; Brakhman, E.V.; Galaktionov, Y.V.; Gorodkov, Y.V.; Danilov, M.V.; Eliseev, G.P.; Ermilov, A.I.; Zel'dovich, O.Y.; Laptin, L.P.; Lyubimov, V.A.; Nagovitsyn, V.V.; Plyaskin, V.V.; Sopov, V.S.; Tikhomirov, I.N.; Tsvetkova, T.N.; Shepelev, V.V.; Shumilov, E.V. (Institute of Theoretical and Experimental Physics). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 367-370(20 Apr 1977).

We investigated the backward elastic π^-p scattering at primary momenta 24.7 and 37.8 GeV/c using a magnetic spectrometer with hybrid spark chambers. Experimental results are presented on the dependence of the differential cross section $d\sigma/du$ on the squared momentum transfer u, and also on the energy dependence of $d\sigma/du$ at u=0.

9218 Reaction $\pi^-p \rightarrow X^0n$, $X^0 \rightarrow 2\gamma$ at momenta 15 and 40 GeV/c. Apel, W.D.; Bertolucci, E.; Vincelli, M.L.; Donskov, S.V.; Johnson, R.; Inyakin, A.V.; Kachanov, V.A.; Kittenberger, W.; Krasnokutskii, R.N.; Leder, G.; Lednev, A.A.; Mannelli, I.; Mikhailov, Y.V.; Muller, H.; Prokoshkin, Y.D.; Pierazzini, G.M.; Sergiampetri, F.; Sigurdson, G.; Scribano, A.; Schinzel, D.; Schneider, H.; Steuer, M.; Shuvalov, R.S. (Cooperative experiment of the Institute of High Energy Physics (Serpukhov, USSR) and CERN (Geneva, Switzerland)). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 300-301(Mar 1977).

The cross sections of the reactions $\pi^-p \rightarrow X^0n$ with the decay $X^0 \rightarrow 2\gamma$ were measured at momenta 15 and 40 GeV/c. About 500 events were registered. The γ^- quantum pairs were detected with a hodoscopic spectrometer on line with a computer. The t-dependence of the differential cross section was found to be similar to that of the reaction $\pi^-p \rightarrow$etan. The angle of the singlet-octet mixing of the pseudoscalar mesons was determined from the ratio of the differential cross sections for the production of X^0 and eta mesons at t=0 and found to be $\beta = -(16 +- 2)^\circ$.

9219 Investigation of the reaction $\pi^-p \rightarrow K^0K^0n$ at 50 GeV/c. Bolonkin, B.V.; Vladimirskii, V.V.; Grigor'ev, V.K.; Grishin, A.P.; Erofeev, I.A.; Korol'kov, I.Y.; Luzin, V.N.; Pligin, Y.S.; Sokolovskii, V.V.; Tikhomirov, G.D.; Trostina, K.A.; Shkurenko, Y.P. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 302-304(Mar 1977).

About 300 events of the reaction $\pi^-p \rightarrow K^0K^0n$ at 50 GeV/c are analyzed. Cross sections in several regions of the mass spectrum of the K^0K^0 system are presented. The angular distributions and mass spectrum of this system are consistent with previous data at 40 GeV/c and lower momenta.

9220 Comparison of experimental distributions of rapidity intervals in inelastic π^-p interactions at 60 GeV with the multiperipheral cluster model. Adamovich, M.I.; Volkov, E.I.; Larionova, V.G.; Orlova, G.I.; Tret'yakova, M.I.; Kharlamov, S.P.; Chernyavskii, M.M.; Yagudina, F.R. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 309-311(Mar 1977).

The experimental distributions of the rapidity intervals of charged particles produced in π^-p interactions at 60 GeV are presented for events with multiplicity n=6, 8, and 10. They are compared to the distributions given by the multiperipheral cluster model. The theoretical model describes the experimental data well. The clusterization of particles is shown to be important.

9221 Associated multiplicities in the reactions $K^+p \rightarrow K^0X$ and $K^+p \rightarrow \pi^-X$ at 32 GeV/c. Azhinenko, I.V.; De Beer, M.; Vanderbogaert, F.; Gerdyukov, L.N.; Gysen, M.; Dujardin, C.; Kesteman, J.; Csejthey-Barth, M.; Kubik, V.M.; Laberrigue, J.; Laurent, J.; Loret, M.; Manyukov, B.A.; Minaev, N.G.; Nguyen, N.K.; Rybin, A.M.; Ryadovikov, V.N.; Saudraix, J.; Strachman, Z.; Schlesinger, J.; Shlyapnikov, P.V. (Joint Franco-Soviet and CERN-Soviet Collaborations). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 312-314(Mar 1977).

Results are presented of an investigation of the dependence of the associated multiplicity $<n(M^2)>$ of charged particles on the effective mass squared M^2 of the system X in the inclusive reactions $K^+p \rightarrow K^0X$ and $K^+p \rightarrow \pi^-X$ at 32 GeV/c. A connection is established between the associated multiplicities and the inclusive correlations. The results are compared with data obtained at lower energies.

9222 Secondary-charged-particle multiplicities for π^-p and π^-n interactions at 40 GeV/c. Angelov, N.S.; Backovic, S.; Grishin, V.G.; Nagy, J. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 315(Mar 1977).

Topological cross sections have been obtained for π^-p and π^-n interactions at 40 GeV/c. Corrections have been made for elastic and coherent interactions, γ quanta, and Dalitz pairs.

9223 Search for correlations between production of high-energy helium nuclei and generation of shower particles. Borisenko, A.I.; Kazankaya, A.P.; Morozova, P.V.; Takibaev, Z.S.; Kopzhasarova, K.A. (Kazakh State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 319-322(Mar 1977).

The nature of the change in the relative probability for production of helium nuclei with kinetic energy greater than 100 MeV with increase of the number of gray and thin tracks in the disintegration is studied. The azimuthal distributions of shower parti-

cles with respect to the helium nuclei are analyzed for various energies of the interacting hadrons. It is shown that production of helium nuclei of high energies cannot be explained by absorption of π mesons produced in the nucleus.

9224 Characteristics of protons emitted into the backward hemisphere in pion-nuclear interactions. Gornov, M.G.; Lapushkin, S.V.; Orlov, V.I.; Pichugin, A.P.; Ponosov, A.K.; Sergeev, F.M. (Moscow Engineering-Physics Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 322-326(Mar 1977).

To study the mechanism of pion-nucleus collisions leading to emission of protons into the backward hemisphere, we have analyzed the characteristics of such protons arising in reactions induced by 3.9-GeV/c π^- mesons. Stars with two protons emitted backwards are discussed in detail. Angular and momentum distributions are obtained, and also the distribution in the binding energy of the two protons in the backward hemisphere. The experimental data indicate that emission of the protons occurs independently of each other. The multiplicity of protons emitted backward, the total multiplicity of protons in the star, and the multiplicity of relativistic particles reveal simple mutual relationships which are close to linear. It is concluded that most protons with momentum greater than 250 MeV/c emitted from a nucleus in its disintegration, including protons in the backward hemisphere, are due to a single mechanism.

9225 Scaling properties of proton emission in $\pi^+ + Xe \rightarrow p^+ ....$ interactions at 2.34 GeV/c. Slowinski, B.; Strugalski, Z. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 326-330(Mar 1977).

The energy spectra of the protons emitted in the interactions $\pi^+ + Xe \rightarrow kp + ...$ at 2.34 GeV/c for k=1 to 10 are analyzed. It is observed that the slope parameter ϵ_0 of the function E/sub t/$(d^3\sigma/dp^3) \sim$ a exp (-E/sub k//ϵ_0), that approximates the relativistically invariant backward proton-emission cross section, depends on the number of emitted protons and does not depend on their emission angle (E/sub t/ is the total proton energy). Results are also presented of an analysis of analogous characteristics of forward-emitted protons of intermediate kinetic energy, E/sub k/=30 to 210 MeV. It is observed in particular that the emission cross section of these protons is satisfactorily described by the same exponential function.

9226 K^0/sub L/—K^0/sub S/ transmission regeneration in hydrogen. Savin, I.A. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 11-29(Jan 1977).

The existing experimental data on K^0/sub L/—K^0/sub S/ regeneration in hydrogen at high energies are compared with the predictions based on complex-angular-momentum theory and dispersion relations. The review opens with a brief description of the fundamentals of the theory and the methods of observation of regeneration.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

9227 (FERMILAB-Conf—77/27-THY) **Issues in charmed particle spectroscopy.** Quigg, C. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1977. Contract EY-76-C-02-3000. 4p. Dep. NTIS, PC A02/MF A01.

Questions which remain to be answered about charmed particles and their interactions are listed.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 8963

9228 Production of Y (9.5) in e^+e^- annihilation and photoproduction. Aubrecht, G.J. II; Wada, W.W. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev. Lett.;* **39**: No. 16, 978-980(17 Oct 1977).

On the assumption that the new resonance Y (9.5) is a vector meson its leptonic- and hadronic-decay widths are calculated in analogy to those of psi (3.1). Then, using the Breit- Wigner formula, the production cross section in e^+e^- annihilation is predicted. The tensor dominance of the Pomeron, together with the vector dominance model, is invoked to estimate the photoproduction cross section.

9229 Y (9.5) as bound states of new heavy quarks. Carlson, C.E.; Suaya, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **39**: No. 15, 908-911(10 Oct 1977).

The cascade-gluon model is used to show that the observed enhancement at 9.5 GeV can be interpreted as due to the production, and subsequent cascade decay into $^3S_1$ states, of at least two and most likely three sets of C = + bound states of quarks Q of mass m/sub Q/ $\cong$ 5 GeV and charge -1/3e.

9230 Photoproduction of J/psi mesons in the peripheral model. The diffraction mechanism. Boreskov, K.G.; Ioffe, B.L. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 331-335(Mar 1977).

An analysis is made of a mechanism for the photoproduction of J/psi mesons on nucleons with an imaginary amplitude that arises as the shadow of the amplitudes for the photoproduction of charmed particles. It is possible to describe the experimental data by means of this mechanism only if at moderate energies E/sub γ/GeV a major role is played by processes involving the production of a charmed baryon and meson or a pair of charmed mesons in a resonant state, while at high energies the dominant processes involve the photoproduction of pairs of charmed mesons accompanied by hadrons, with a cross section that exceeds the cross section for the photoproduction of psi mesons by more than an order of magnitude.

9231 Mass differences in isotopic multiplets. Geshkenbein, B.V.; Smilga, A.V. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 361-363(Mar 1977).

The microcausality condition, which makes it possible to express the amplitudes T/sub i/(ν,q^2) for forward scattering of a virtual photon by a hadron in terms of the functions W/sub i/(ν,q^2) that describe the electroproduction process, is used to explain the mass difference between particles of an isotopic multiplet. It is shown that the mass difference in doublets does not depend on the electroproduction. Possible variants of the explanation of the observed mass difference are considered.

9232 Effect of target recoil and excitation in bremsstrahlung and pair production processes. Bugaev, E.V. (Institute of Nuclear Research, Academy of Sciences of the USSR). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 12-16(Jan 1977).

The formulas for the bremsstrahlung and pair production processes in lepton-nuclear collisions are extended to the case when these processes are accompanied by arbitrary excitation of the nucleus (or of any other target with a structure). Exact expressions are obtained, and approximations valid only at relativistic energies are made. It is shown by way of example that the nuclear electromagnetic form-factor is taken into account, the cross section for bremsstrahlung from a muon in a nuclear field decreases by 10—15%.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 9226

9233 Mixing of states containing heavy quarks. Paschos, E.A. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 14, 858-861(3 Oct 1977).

I discuss the mixing of states containing heavy quarks with new quantum numbers. The mixing of the new states can be substantial in gauge theories with right-handed currents, even though direct neutral couplings conserve all flavors. Some experimental implications of the results are discussed.

9234 Processes $\mu \rightarrow e+\gamma$, $\mu \rightarrow e+e+$e-bar, $\nu' \rightarrow \nu+\gamma$ in the Weinberg-Salam model with neutrino mixing. Petkov, S.T. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 340-344(Mar 1977).

In a modified Weinberg-Salam model with neutrino mixing we have calculated the probabilities for the decay modes $\mu \rightarrow e+\gamma$, $\mu \rightarrow e+e+$e-bar, and $\nu' \rightarrow \nu+\gamma$.

9235 Radiative corrections to the decay $K^+ \rightarrow \pi^+ \mu^+ \mu^-$. Shabalin, E.P. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 344-346(Mar 1977).

The Weinberg-Salam theory is used to estimate the effects of radiative corrections which modify the soft part of the pion spectrum in the decay $K^+ \rightarrow \pi^+ \mu^+ \mu^-$.

9236 Nucleon form factors and light-front dynamics. Berestetskii, V.B.; Terent'ev, M.V. (Institute of Theoretical and Experimental Physics of the State Committee for the Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 347-354(Mar 1977).

The structure of electromagnetic and weak currents is investigated in a relativistically invariant model in which nucleons are considered as bound states of three light quarks in light-front dynamics. Magnetic moments and large momentum transfer asymptotics of the nucleon elastic form factors are calculated. The deep inelastic form factors are evaluated and their relation to the elastic-form-factor asymptotics is discussed. Sum rules and relations between neutrino electroproduction and scattering on nucleons are derived in the framework of the considered model. For many examples the

model provides a good fit to the data but one of the sum rules leads to a contradiction.

9237 Deep inelastic neutrino processes. Bilen'kii, S.M. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 30-45(Jan 1977).

Deep inelastic neutrino processes are considered and in particular the reactions ν/sub μ//sub(μ)+N→μ (mu-bar)+ hadrons (phenomenology, parton model, experimental data). Unified theories of the weak and electromagnetic interaction are presented and the processes ν/sub μ//sub(μ)+N→ν/sub μ//sub(μ)+ hadrons considered. Dimuonic events and vector-like theories of the weak interaction are also discussed.

9238 Properties of heavy leptons and their manifestation in the e^+e^-→hadrons reaction. Azimov, Y.I.; Frankfurt, L.L.; Khoze, V.A. (B. P. Konstantinov Institute of Nuclear Physics, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 32-37(Jan 1977).

The manifestations of heavy leptons in various characteristics of e^+e^- annihilation are examined. The properties of the heavy-lepton decays and their contributions to R (s) and ϵ (s) are discussed with allowance for event-selection effects. The inclusive spectra of the secondary particles are also discussed. It is shown that the characteristic properties expected for the heavy leptons are consistent with the data on anomalous muon production.

STRONG INTERACTIONS, BARYON NO.=0

9239 Application of the quark-confining string to the psi spectroscopy. Giles, R.C.; Tye, S.H. (Stanford Linear Accelerator Center, Stanford University, Standord, California 94305). *Phys. Rev., D;* **16**: No. 4, 1079-1095(15 Aug 1977).

We report the results of the nonrelativistic application of the quark-confining string model to the study of psi spectroscopy. This string model is defined by a relativistic-invariant, gauge-invariant, and reparametrization-invariant action describing quarks interacting with color SU(3) gauge fields. The model has no gluonic degrees of freedom, but has instead string degrees of freedom. Quark masses and the quark-gluon coupling constant are the only parameters of the model. In the Schroedinger limit and in the absence of light quarks, the longitudinal modes of the quark-antiquark pair and the rotational modes of the string for a meson reduce to the charmonium model with a linear potential. String vibrations, which are absent in the charmonium model, provide additional levels. They start coming in at around 4.0 GeV; the density of states increases as an exponential function of the mass. The two lowest vibrational levels in the e^+e^- channel have energies at 4.0 GeV and 4.4 GeV. Relativistic corrections are estimated to be small for the low-lying states so that the Schroedinger approximation is justified. We consider this application to psi spectroscopy as a test of the model.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 9226

9240 (ORO—3992-314) **Real and imaginary parts of hadronic amplitudes, diffractive contribution, and the Chew-Rosenzweig Pomeron.** Chiu, C.B.; Tow, D.M. (Texas Univ., Austin (USA). Dept. of Physics). Jul 1977. Contract EY-76-S-05-3992. 13p. Dep. NTIS, PC A02/MF A01.

It is shown that when the f' and the diffractive elastic (and quasi-elastic) contributions are included within the Chew-Rosenzweig type solution for the Pomeron, one can explain reasonably well the π and (2K-π) total cross sections as well as the ratios of the real over imaginary parts of the forward π and K amplitudes.

9241 Multiple particle production at high energy. Comparison with experimental data. Ter-Martirosyan, K.A.; Shabel'skii, Y.M. (Institute of Theoretical and Experimental Physics, State Atomic Energy Commission). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 356-360(Mar 1977).

A theory of the multiplicity distribution of produced particles [K. A. Ter-Martirosyan and Yu. M. Shabel'skii, Yad. Fiz. 25, 670 (1977)] is compared with the experimental data. It is shown that theoretical expressions based on results of Abramovskii, Gribov, and Kancheli provide a good description of the experimentally observed effect of a considerable broadening of the multiplicity distribution with increasing energy.

9242 Use of superpropagators for the description of πN-scattering s and p waves in nonlinear chiral dynamics. Gaisak, M.I.; Lend'el, V.I. (Institute of Theoretical Physics, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 363-370(Mar 1977).

A dynamic description of πN-scattering s and p waves is obtained with account taken of diagrams of second, third, and fourth order in the fundamental coupling constant in a nonlinear chiral Lagrangian with exponential parametrization and without introducing any arbitrary parameters whatever. The single-loop diagrams are obtained with the aid of the superpropagator method of regularization. The partial amplitude is reconstructed in the diagonal (1,1) Pade approximation. Both the energy dependence and the positions of the singularities in the s and p waves are in quite satisfactory agreement with the experimental data.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

9243 (IS-T—775) **Comparison between phase shift derived and exactly calculated nucleon—nucleon interaction matrix elements.** Gregersen, A.W. (Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Physics). 1975. Contract W-7405-ENG-82. 191p. Dep. NTIS, PC A09/MF A01.

A comparison is made between matrix elements calculated using the uncoupled channel Sussex approach to second order in DWBA and matrix elements calculated using a square well potential. The square well potential illustrated the problem of the determining parameter independence balanced with the concept of phase shift difference. The supersoft core potential was used to discuss the systematics of the Sussex approach as a function of angular momentum as well as the relation between Sussex generated and effective interaction matrix elements. In the uncoupled channels the original Sussex method of extracting effective interaction matrix elements was found to be satisfactory. In the coupled channels emphasis was placed upon the $^3S_1$-$^3D_1$ coupled channel matrix elements. Comparison is made between exactly calculated matrix elements, and matrix elements derived using an extended formulation of the coupled channel Sussex method. For simplicity the potential used is a nonseparable cut-off oscillator. The eigenphases of this potential can be made to approximate the realistic nucleon-nucleon phase shifts at low energies. By using the cut-off oscillator test potential, the original coupled channel Sussex method of determining parameter independence was shown to be incapable of accurately reproducing the exact cut-off oscillator matrix elements. The extended Sussex method was found to be accurate to within 10%. The extended method is based upon more general coupled channel DWBA and a noninfinite oscillator wave function solution to the cut-off oscillator auxiliary potential. A comparison is made in the coupled channels between matrix elements generated using the original Sussex method and the extended method. Tables of matrix elements generated using the original uncoupled channel Sussex method and the extended coupled channel Sussex method are presented for all necessary angular momentum channels.

9244 Fragmentation of relativistic heavy ions. Feshbach, H.; Zabek, M. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Ann. Phys. (N.Y.);* **107**: No. 1, 110-125(6 Sep 1977).

A simple explanation of the phenomena observed when relativistic heavy ions are fragmented upon colliding with a variety of target nuclei is developed. Explanations are provided for the approximately isotropic angular distribution of each fragment type, for the small momentum and energy transfer to the projectile nucleus, for the independence of the branching ratio with respect to the target nucleus and for the approximate energy independence.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

9245 U(1) x SU(4)/sub L/ x SU(4)/sub R/-based weak-electromagnetic synthesis with manifest left-right symmetry. Beg, M.A.B.; Mohapatra, R.N.; Sirlin, A.; Tsao, H. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 17, 1054-1057(24 Oct 1977).

We pesent a gauge theory of weak and electromagnetic interactions which is based on the group U(1) x SU(4)/sub L/ x SU(4)/sub R/ and which implements manifest left-right symmetry in a natural way. The theory is characterized by a rich lepton spectrum and is consistent with recent experimental results in atomic physics and weak trimuon production. Some novel predictions of the theory are discussed.

FIELD THEORY

9246 New class of superalgebras and local gauge groups in superspace. Mansouri, F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *J. Math. Phys. (N.Y.);* **18**: No. 12, 2395-2396(Dec 1977).

It is shown that there is a new class of superalgebras associated with a given Lie algebra or a superalgebra. The structure constants of the new algebras either vanish or else are directly related to those of the original algebra. The new algebraic structures provide a possible link between the local gauge groups constructed over superspace and those over ordinary space—time.

9247 Regularization and renormalization of quantum field theory in curved space-time. Bernard, C.; Duncan, A. (Department of Physics, Columibia University, New York, New York 10027). *Ann. Phys. (N.Y.);* **107**: No. 1, 201-221(6 Sep 1977).

It is proposed that field theories quantized in a curved space-time manifold can be conveniently regularized and renormalized with the aid of Pauli—Villars regulator fields. The method avoids the conceptual difficulties of covariant point-separation approaches, by always starting from a manifestly generally covariant action, and the technical limitations of the dimensional regularization approach, which requires solution of the theory in arbitrary dimension in order to go beyond a weak-field expansion. An action is constructed which renormalizes the weak-field perturbation theory of a massive scalar field in two space-time dimensions, it is shown that the trace anomaly previously found in dimensional regularization and some point-separation calculations also arises in perturbation theory when the theory is Pauli—Villars regulated. We then study a specific solvable two-dimensional model of a massive scalar field in a Robertson—Walker asymptotically flat universe. It is shown that the action previously considered leads, in this model, to a well-defined finite expectation value for the stress-energy tensor. The particle production (<0 in vertical-barθ/sup munu(x ,t)/vertical-bar0 in> for t→+ ∞) is computed explicitly. Finally, the validity of weak-field perturbation theory (in the appropriate range of parameters) is checked directly in the solvable model, and the trace anomaly computed in the asymptotic regions t→ +- ∞ independently of any weak-field approximation. The extension of our model to higher dimensions and the renormalization of interacting (scalar) field theories are briefly discussed.

9248 Some properties of monopole harmonics. Wu, T.T.; Yang, C.N. (Gordon McKay Laboratory, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **16**: No. 4, 1018-1021(15 Aug 1977).

Some properties of monopole harmonics are derived.

9249 Indefinite-metric fields and the renormalization group. Sherry, T.N. (Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **16**: No. 4, 1026-1035(15 Aug 1977).

We derive the renormalization-group equations for the Green's functions of an indefinite-metric field theory. In these equations we retain the mass dependence of the coefficient functions, since in the indefinite-metric theories the masses cannot be neglected. The behavior of the effective coupling constant in the asymptotic and infrared limits is analyzed. We illustrate the analysis by means of a simple model incorporating indefinite-metric fields. The model scales at first order, and at this order also the effective coupling constant has both ultraviolet and infrared fixed points, the former being the bare coupling constant.

9250 Gauge vacuums and the conformal group. Balachandran, A.P.; Din, A.M.; Nilsson, J.S.; Rupertsberger, H. (Physics Department,Syracuse University, Syacuse, New York 13210). *Phys. Rev., D;* **16**: No. 4, 1036-1040(15 Aug 1977).

Recent discussions on the degeneracy of classical gauge vacuums assume that spacelike hypersurfaces in an (n + 1) -dimensional space-time have the topology of n-dimensional spheres. We point out a connection between this assumption and the requirement that the conformal group acts properly as a group of transformations on space-time. The latter is possible only if the Minkowski space M/sup n/ is enlarged to a compact manifold M/sup n/ by the addition of suitable points at infinity. Spacelike hypersurfaces in M/sup n/ do indeed have the topology of S/sup n/.

9251 Propagators in the presence of a Yang-Mills pseudoparticle. Ore, F.R. Jr. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 4, 1041-1051(15 Aug 1977).

Propagators for ghosts and small oscillations of the Yang-Mills field in the field of the pseudoparticle solution of Belavin, Polyakov, Schwartz, and Tyupkin are derived, using the O(5) formalism. Group-theoretical methods are derived which allow for complete, analytic solutions for these propagators, which are exhibited both for the O(4) and SU(2) gauge groups.

9252 Spinor analysis of Yang-Mills theory. Jackiw, R.; Rebbi, C. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 4, 1052-1060(15 Aug 1977).

We formulate the Euclidean Yang-Mills gauge theory for isospin in terms of multispinors of SU(2) x SU(2)[=O(4)] x SU(2). The Dirac equation for fermions with arbitrary isospin interacting with the self-dual, conformally covariant Yang-Mills field is analyzed and completely solved for the isovector case. The relevance for this problem of the Atiyah-Singer index theory and its relation to the anomalous divergence of the axial-vector current are also explained.

9253 Fermion-field nontopological solitons. II. Models for hadrons. Friedberg, R.; Lee, T.D. (Barnard College and Columbia University, New York, New York 10027). *Phys. Rev., D;* **16**: No. 4, 1096-1118(15 Aug 1977).

We examine the possibility, and its consequences, that in a relativistic local field theory, consisting of color quarks q, scalar gluon σ, color gauge field V/sub μ/and color Higgs field phi, the mass of the soliton solution may be much lower than any mass of the plane-wave solutions; i.e., the quark mass m/sub q/, the gluon mass m/sub sigma/etc. There appears a rather clean separation between the physics of these low-mass solitons and that of the high-energy excitations, in the range of m/sub q/ and m/sub sigma/provided that the parameters ξ equivalent (μ/m/sub q/)^2 and eta equivalent μ/m/sub sigma/are both $<<1$, where μ is an overall low-energy scale appropriate for the solitons [but the ratio eta/ξ is assumed to be O (1), though otherwise arbitrary]. Under very general assumptions, we show that, independently of the number of parameters in the original Lagrangian, the mathematical problem of finding the quasi-classical soliton solutions reduces, through scaling, to that of a simple set of two coupled first-order differential equations, neither of which contains any explicit free parameters. The general properties and the numerical solutions of this reduced set of differential equations are given. The resulting solitons exhibit physical characteristics very similar to those of a "gas bubble" immersed in a "medium": there is a constant surface tension and a constant pressure exerted by the medium on the gas; in addition, there are the "thermodynamical" energy of the gas and the related gas pressure, which are determined by the solutions of the reduced equations. Both a SLAC-type bag and the Creutz-Soh version of the MIT bag may appear, but only as special limiting cases. These soliton solutions are applied to the physical hadrons; their static properties are calculated and, within a 10—15% accuracy, agree with observations.

9254 Fermions and gauge vector mesons at finite temperature and density. I. Formal techniques. Freedman, B.A.; McLerran, L.D. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 4, 1130-1146(15 Aug 1977).

We construct the thermodynamic potential for quantum electrodynamics and quantum chromodynamics at finite temperature and density. We find the thermodynamic potential as a functional of the full propagators and vertices. This functional is stationary under variations of the full propagators and vertices by virtue of the Schwinger-Dyson equations, and may be interpreted as a classical action. We also discuss the renormalization of the propagators and vertices.

9255 Fermions and gauge vector mesons at finite temperature and density. II. The ground-state energy of a relativistic electron gas. Freedman, B.A.; McLerran, L.D. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 4, 1147-1168(15 Aug 1977).

We calculate the ground-state energy of a relativistic electron gas up to and including effects of order $\alpha^2 \log\alpha$ and α^2. Cutting rules are developed which relate a vacuum-graph expansion for the thermodynamic potential to phase-space integrals over Feynman amplitudes. Overlapping infrared divergences, which cancel when all contributions of order α^2 are summed, are treated by performing a dimensional continuation to $4 + \epsilon$ dimensions. Ultraviolet divergences associated with electron wave-function and charge renormalizations are rendered finite by use of a Landau gauge appropriate to $4 + \epsilon$ dimensions.

9256 Fermions and gauge vector mesons at finite temperature and density. III. The ground-state energy of a relativistic quark gas. Freedman, B.A.; McLerran, L.D. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 4, 1169-1185(15 Aug 1977).

We calculate the ground-state energy of a quark gas up to and including effects of fourth order in the quark-gluon coupling. Renormalization-group techniques are used to rewrite the results of the fourth-order calculation in terms of a chemical-potential-dependent coupling. The chemical-potential-dependent coupling approaches zero at high densities. We argue that at hadronic matter densities a phase transition between quark matter and hadronic matter occurs. We show the existence of this phase transition for a three-color, one-flavor quark gas. We find a close correspondence between the results of quantum chromodynamics at large coupling with no bag constant and quantum chromodynamics at small coupling with a bag constant.

9257 One-component formulation of Reggeon field theory. Harms, B.C.; Tan, C. (Department of Physics and Astronomy, University of Alabama, University, Alabama 35486). *Phys. Rev., D;* **16**: No. 4, 1186-1205(15 Aug 1977).

We present a nonperturbative formulation of the anti-Hermitian cubic Reggeon field theory (RFT) in terms of a single field chi. We analyze the structure of RFT as α_0 is increased above 1 and clarify the relation between the perturbative vacuum and the classical stationary points. A canonical transformation is performed so that the new Hamiltonian depends on the sign of Δ_0 equivalent 1 - α_0 only through a potential of the Landau-Ginzburg type. Our one-component theory is normal-ordered with respect to the original Pomeron field without tadpoles, and it allows a path-integral formalism with undistorted contours. For Δ_0 / g_0 large and $\Delta_0 < 0$, we formulate two different and yet equivalent analog models. We unambiguously derive an analog model in terms of a single classical spin at each rapidity—impact-parameter site. Through the use of an asymmetrical transfer matrix, we obtain a kinklike ground-state configuration for the D = 0 model. Alternatively, by going on a lattice for the impact-parameter space only, we arrive at a quantum lattice-spin model. We explicitly demonstrate that the quantum spin model at D = 0 is equivalent to the classical lattice spin model.

9258 Massless propagators on the light cone. Hagen, C.R.; Yee, J.H. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **16**: No. 4, 1206-1210(15 Aug 1977).

The propagators of free spin-0 and spin-1/2 fields are considered in two-dimensional light-cone coordinates. It is shown by explicit construction that although the differential equations for the propagators are identical to those conventionally obtained the solutions differ from the usual space-time form by the addition of terms dependent only upon the "time" coordinate. The results obtained are confirmed by recourse to the usual plane-wave expansions of the scalar and spinor fields.

9259 Symmetry groups in quantum field theory. Konopel'chenko, B.G. (Institute of Nuclear Physics, Novosibirsk). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 1, 57-72(Jan 1977).

Symmetry and supersymmetry groups in quantum field theory are reviewed. These include spacetime symmetry groups (Lorentz, Poincare, Weyl, conformal) and internal symmetry groups with scalar and spinor parameters (supersymmetry groups). The main attention is devoted to the existence of the various symmetry groups. It is shown that the requirement of relativistic invariance leads to strong restrictions on the structure of the possible symmetry groups.

9260 (SLAC-Trans—176) Instability of non-Abelian gauge theories and impossibility of choice of Coulomb gauge. Gribov, V.N. 1977. Translation by H.D.I. Abarbanel of USSR report. 24p. Dep. NTIS, PC A02/MF A01.

It is demonstrated that by virtue of the impossibility of introducing Coulomb gauge for large fields and of the growth of the invariant charge at large distances, non-Abelian gauge theories may not be formulated as a theory of interacting massless particles. This assertion appears as a strong argument in favor of the idea that the spectrum of states in non-Abelian theories is substantially different from the spectrum of states in perturbation theory.

SCATTERING THEORY

9261 Analytic evaluation of an important integral in collision theory. Detrich, J.; Conn, R.W. (Nuclear Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). *J. Math. Phys. (N.Y.);* **18**: No. 12, 2348-2351(Dec 1977).

A commonly occurring integral in collision theory when the radial part of the potential has the form r/sup n/e/sup -alphar/ is I/ sub n (l l prime(alpha(k ,k)/ = ∫/sup infinity0/dr r/sup n/ e/sup - alphar/J/sub l/(kr) J/sub l/(k'r). Analytic results for this integral have been found for the most important cases, including those with negative values of n. This permits efficient evaluation of Born matrix elements required in many scattering theory applications based on perturbation methods.

9262 Unitarity relation and phase shift analysis in a system comprising a resonance and a particle. Simonov, Y.A.; Badalyan, A.M. (Institute for Theoretical and Experimental Physics). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 29-32(Jan 1977).

Unitarity relations are recorded in explicit form for the amplitude of scattering of a resonance by a particle and for the amplitude for the creation of a resonance and a particle. The solution of these unitarity relations is found, and a representation is obtained for the amplitude for creation B in which all the corrections for rescattering have been taken into account. It is shown that the phase of the amplitude B is a sum of two terms: one of them corresponds to a long-range interaction between the resonance and the particle and an explicit expression is obtained for it; the other term originates from the left (potential) singularities of the amplitude and is the proper phase for the resonance-particle system. The results obtained enable us to carry out correctly a phase analysis for the resonance plus particle system and to improve the procedure employed in the well-known phase analysis of the Illinois group.

PHYSICS RESEARCH (CONT.)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

MOMENTS AND SPIN

9263 Analytic wave function for the deuteron D states. Adler, R.J.; Das, T.K.; Filho, A.F. (Stanford Linear Accelerator Center, Stanford, California 94305). *Phys. Rev., C;* **16**: No. 3, 1231-1234(Sep 1977).

For calculations involving the deuteron S-state wave function it is common to use the asymptotic form for a rough approximation and the ad hoc Hulthen form for a better estimate. The two parameters of the Hulthen function are determined by the deuteron binding energy and the singlet effective range. In like manner we propose an ad hoc analytic form for the D-state wave function, which contains two parameters which are determined by the deuteron quadrupole moment and D-state percentage. The resultant function coincides very closely with the functions obtained from serveral widely used potential models. Since the chief value of such an analytic wave function is to calculate matrix elements quickly and easily we explicitly calculate a form of integral that allows a large class of matrix elements to be evaluated immediately.

NUCLEAR REACTIONS AND SCATTERING

9264 Separable-potential fits to resonance parameters. Lehman, D.R.; Gibson, B.F. (Department of Physics, The George Washington University, Washington, D. C. 20052). *Phys. Rev., C;* **16**: No. 3, 1275-1277(Sep 1977).

The strength and range parameters of simple separable potentials for n-α scattering are determined from knowledge of the resonance-pole locations in the P/sub 1/2/ and P/sub 3/2/ n-α scattering amplitudes. The phase shifts associated with these potentials are compared with experiment. Agreement with the experimental phase shift is good for the P/sub 3/2/ case where the resonance is sharp; however, the predicted phase shift for the broad P/sub 1/2/ "resonance" is poor. The results are interpreted on the basis of the resonance-pole proximity to the physical region.

9265 pd scattering at large angles. Smorodinskaya, N.Y. (Institute of Theoretical and Experimental Physics, State Commission on Use of Atomic Energy). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 285-286(Mar 1977).

Elastic pd scattering backward is studied in terms of the model of resonance one-pion exchange. Calculations carried out with various wave functions are compared with the experimental data.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

9266 (IC—76-77) Faddeev equations for the ^{6}Li nucleus. Osman, A. (International Centre for Theoretical Physics, Trieste (Italy)). Aug 1976. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The ^{6}Li nucleus is considered as composed of an alpha particle, a proton and a neutron. With this construction the ^{6}Li nucleus is studied as a three-body problem. The Faddeev equations are given, taking separable potentials for the interaction between the alpha, the proton and the neutron particles in pairs. The nucleon-nucleon potential is taken as a central term of the Yamaguchi type and also including a tensor force. To investigate the short-range correlations in this three-body system, the nucleon-nucleon potential is taken to include a repulsive soft-core part in addiation to the attractive part ocnsidered. The nucleon-alpha potential is taken as central and spin-orbit terms which fit the corresponding experimental nucleon-alpha phase shifts. The effect of Coulomb forces between the proton and the alpha particle is taken into account. Solving the coupled Faddeev equations numerically, the binding energies for the ground and excited states of ^{6}Li are calculated. Inclusion of repulsive-core effects is found to change the results by 19%.

NUCLEAR REACTIONS AND SCATTERING

9267 **Elastic scattering of slow π mesons by nuclei.** Bunatyan, G.G.; Pol', Y.S. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 287-292(Mar 1977).

A detailed analysis is carried out of elastic scattering of slow π mesons by nuclei. Interaction of the π mesons with nuclei is described by means of an effective quasipotential V/sub eff/ constructed similarly to the quasipotential for the bound states of a π meson in mesic atoms. Use is made of the most complete variant of this potential, including corrections not previously taken into account. A detailed study is made of the dependence of the results on the shape of the nuclear density distribution. A rather good quantitative description of the experimental data is obtained for scattering of π^{+-} mesons with energies T/sub π/MeV. For T/sub π/MeV only a qualitative description of the experiments is obtained.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

9268 **Strong effect of isospin mixing in ^{16}O.** Wagner, G.J.; Knoepfle, K.T.; Mairle, G.; Doll, P.; Hafner, H.; Ford, J.L.C. Jr. (Max-Planck-Institut fuer Kernphysik, D-69 Heidelberg, Germany). *Phys. Rev., C;* **16**: No. 3, 1271-1274(Sep 1977).

The intensity ratio of the ground state (2^-) to the 0.30 MeV (3^-) state of ^{16}N as measured in the ^{17}O(d,^{3}He) reaction and the intensity ratio of their analog states at 12.97 and 13.26 MeV in ^{16}O as measured in the ^{17}O(d,t) and ^{17}O(^{3}He,α) reactions consistently differ by about 50%. A largely model independent analysis of this isospin mixing effect in ^{16}O suggests > or =17% mixing of the 2^- states at 12.97 (T = 1) and 12.53 MeV (T = 0) as its dominant source, in which case a lower limit of the isospin mixing matrix element of (155 +- 30) keV is obtained.

NUCLEAR REACTIONS AND SCATTERING

9269 (ORO—3924-29, pp 12-15) **Mechanisms for Li and Be production in the ^{14}N + ^{12}C reaction.** Stokstad, R.G.; Namboodiri, M.N.; Chulick, E.T.; Natowitz, J.B.; Hanson, D.L. Jul 1977.

In Angular momentum effects in nuclear reactions. Progress report, August 1, 1976—July 31, 1977.

Energy spectra and angular distributions were determined at 86.9 MeV. Theoretical cross sections are plotted as a function of angular momentum cutoff. Yields of Li and Be isotopes are given for 87 and 157 MeV. Data are compared with results of statistical-model calculations. 4 figures, 1 table. (RWR)

9270 **Elastic scattering of ^{14}N ions by ^{6}Li and disintegration of ^{6}Li at 19.5 MeV.** Kumpf, H.; Moesner, J.; Neubert, W.; Schmidt, G. (Central Institute for Nuclear Research, Academy of Sciences, GDR, Rossendorf). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 259-263(Mar 1977).

The angular distribution is measured for the elastic scattering ^{6}Li(^{14}N^{14}N)^{6}Li and analyzed in terms of the optical model. The disintegration ^{6}Li(^{14}N,αd)^{14}N is studied in a kinematically complete experiment. The mechanism of the disintegration process is discussed.

9271 **Angular dependence of the cross section for the (π^+, No. 2p) in lithium nuclei at energy 85 +- 4 MeV.** Nadezhdin, V.S.; Petrov, N.I.; Satarov, V.I.; Vzorov, I.I. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 263-265(Mar 1977).

For the (π^+, 2p) reaction in ^{6}Li and ^{7}Li at 85 +- 4 MeV we have measured the differential cross section as a function of the proton emission angles, the proton separation angle, and the Treiman-Yang angle. We compare the experimental distributions with the corresponding theoretical distributions in the pole approximation. It is shown that to the accuracy achieved in the experiment completely satisfactory agreement exists between the experimental data and the theory.

9272 **Elastic scattering of π^- mesons and protons by nuclei in the region of the diffraction peak at momenta 30—50 GeV/c.** Apolin, V.D.; Vasil'ev, A.N.; Derevshchikov, A.A.; Matulenko, Y.A.; Meshchanin, A.P.; Mysnik, A.I.; Nurushev, S.B.; Saraikin, A.I.; Siksin, V.V.; Smirnov, E.V.; Solov'ev, L.F.; Solov'yanov, V.L. (Institute of High Energy Physics, Serpukhov). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 297-299(Mar 1977).

The total and differential cross sections for elastic scattering of π^- by Li, Be, C, Al, Cu, Sn, and Pb nuclei at initial momenta 33.5, 39.5, 45.5, and 50.5 GeV/c and of protons at 42.5 GeV/c are measured. The squared 4-momentum transfers ranged from 0.002 to 0.04 (GeV/c)^2. The nuclear sizes and the ratios of the real and imaginary parts of the forward elastic-scattering amplitudes were determined from the experimental data.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

9273 (ORO—3924-29) **Angular momentum effects in nuclear reactions. Progress report, August 1, 1976—July 31, 1976.** Natowitz, J.B. (Texas Agricultural and Mechanical Univ., College Station (USA). Cyclotron Inst.). Jul 1977. Contract EY-76-S-05-3924. 55p. Dep. NTIS, PC A04/MF A01.

Separate abstracts were prepared for five sections of the report that contain significant amounts of data. Other sections of the report discuss professional activities and personnel matters. (RWR)

ENERGY LEVELS AND TRANSITIONS

9274 **Deformed-quasiparticle basis for calculating potential energy surfaces and nuclear spectra.** Kumar, K.; Remaud, B.; Aguer, P.; Vaagen, J.S.; Rester, A.C.; Foucher, R.; Hamilton, J.H. (Physics Department, Vanderbilt University, Nashville, Tennessee). *Phys. Rev., C;* **16**: No. 3, 1235-1254(Sep 1977).

The Nilsson model is combined with the Hill-wheeler definition of nuclear deformations and with the stationarity condition of Yariv et al. to calculate a new deformed basis. The wave functions of this basis are the same for neutrons and for protons, and for all mass numbers. The energy levels depend on Z,A via an isospin- A-dependent scaling factor. This basis is combined with an improved theory of pairing to calculate a new deformed-quasiparticle basis. It is shown that without any adjustment of the model parameters from one nucleus to another, this basis leads to reasonable potential energy surfaces for many even-even nuclei (Mg,Zr,Sm,Er,Os,Hg), and reasonable low energy spectra of $^{24}_{12}$Mg, $^{102}_{40}$Zr, and $^{168}_{68}$Er. The Strutinsky method is used to calculate the potential energy surfaces. A modified Kumar-Baranger method is used to calculate the moments of inertia and the mass parameters, and to solve the collective Schroedinger equation.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

9275 (ORO—3924-29, pp 16-20) **Observation of the new nuclides ^{27}Ne, ^{31}Mg, ^{32}Mg, ^{34}Al, and ^{39}P.** Butler, G.W.; Perry, D.G.; Remsberg, L.P.; Poskanzer, A.M.; Natowitz, J.B.; Plasil, F. Jul 1977.

In Angular momentum effects in nuclear reactions. Progress report, August 1, 1976—July 31, 1977.

The new nuclides were observed among the fragments produced by interactions of 800-MeV protons with a uranium target. The experimental details are explained. Mass spectra for the isotopes of Ne, Mg, Al, and P. Good resolution was obtained. 2 figures. (RWR)

ENERGY LEVELS AND TRANSITIONS

9276 **Implications for radiative-strength functions from neutron capture in ^{35}Cl.** Chrien, R.E.; Kopecky, J. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **39**: No. 15, 911-914(10 Oct 1977).

A comparison of neutron-capture γ-ray spectra in neighboring s- and p-wave—capture states in a ^{35}Cl target shows two sharp departures from what is normally expected from a compound-nucleus process. the spectra are highly correlated, with r = +0.84/ sup +0.16//sub -0.10/, and E1 and M1 strengths are comparable. The E1 strength can be explained by the E1 giant resonance; it is consistent with the Axel prediction for a A/sup 8/3/ dependence. M1 strengths agree with single-particle estimates, in sharp contrast to heavy nuclides.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 9272

9277 (ORO—3924-29, pp 5-10) **Detailed studies of the reaction mechanisms of 120-MeV ^{20}Ne with ^{27}Al.** Namboodiri, M.N.; Eggers, R.; Geoffroy, K. Jul 1977.

In Angular momentum effects in nuclear reactions. Progress report, August 1, 1976—July 31, 1977.

Absolute γ-ray multiplicities and relative H and He multiplicities were measured as a function of product atomic number for reactions of 120-MeV ^{20}Ne with ^{27}Al. 6 figures, 2 tables.

9278 Isotope and element distributions of the evaporation residues from fusion of 160 MeV ^{32}S with ^{24,25,26}Mg and ^{27}Al. Puehlhofer, F.; Schneider, W.F.W.; Busch, F.; Barrette, J.; Braun-Munzinger, P.; Gelbke, C.K.; Wegner, H.E. (Gesellschaft fuer Schwerionenforschung GSI, Darmstadt, Germany). *Phys. Rev., C;* **16**: No. 3, 1010-1019(Sep 1977).

Evaporation residues from fusion reactions induced by 160 MeV ^{32}S on targets of ^{24,25,26}Mg and ^{27}Al were identified by means of a time-of-flight ΔE-E detector telescope. Angular distributions were measured in the range from 3° to 16° and total yields were determined as a function of A and Z of the products. The mass distributions of the evaporation residues (summed over Z) show the typical structure arising from the competition between nucleon and α evaporation in the decay of the highly excited (83 to 90 MeV) compound nuclei, with only little variation between the four systems. It is concluded that the deexcitation mechanism is to a large extent independent of the individual structure of the nuclei in the decay chains. This is also demonstrated by the yield distributions for the individual nuclides, in particular by the similarity of the yield patterns obtained in the N-Z plane for the compound nuclei ^{59}Cu and ^{57}Ni. The data are reproduced very well by evaporation calculations based on the statistical theory. Effects of nuclear deformations due to the high angular momentum on the shape of the yrast line and on the transmission coefficients for the emitted light particles were included. The influence of shell effects in the level densities at high excitation was studied and found to be negligible above 15 MeV excitation.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 9275

NUCLEAR REACTIONS AND SCATTERING

9279 Yrast decay schemes from heavy-ion + ^{48}Ca fusion-evaporation reactions II. ^{59,60}Fe and ^{59,60}Co. Warburton, E.K.; Olness, J.W.; Nathan, A.M.; Kolata, J.J.; McGrory, J.B. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **16**: No. 3, 1027-1039(Sep 1977).

Fusion-evaporation reactions induced by beams of 25—55-MeV ^{15}N and ^{18}O on an isotopically enriched ^{48}Ca target have been used to populate high-spin yrast levels in ^{59,60}Fe and ^{59,60}Co. Measurements consisted of γ-ray excitation functions, angular distributions, γ-γ coincidences, and recoil-distance and Doppler-shift lifetime measurements, from which were deduced the energy levels, γ-ray branching ratios, most probable spin-parity assignments, and level lifetimes. The results of p-γ correlation measurements in the ^{58}Fe(t,pγ)^{60}Fe reaction are also reported.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

9280 Statistical analysis of heavy-ion induced fission excitation functions. Bisplinghoff, J.; Mignerey, A.; Blann, M.; David, P.; Scobel, W. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York). *Phys. Rev., C;* **16**: No. 3, 1058-1065(Sep 1977).

The Bohr-Wheeler model has been used with the rotating liquid drop model to calculate fission excitation functions using a computer code with multiple particle emission competition. Calculations were performed for fission induced by ^{35}Cl ions with laboratory energies up to 170 MeV on ^{62}Ni, ^{116}Sn, and ^{141}Pr targets. The dependence of the fission cross sections on angular momentum, barrier heights, ground state and saddle point level density parameters, and for first versus multiple chance fission is illustrated. One set of parameters, not necessarily unique, is shown which gives fair reproduction of the measured ^{116}Sn and ^{141}Pr + ^{35}Cl fission excitation functions. It is shown that fission barriers considerably lower than the rotating liquid drop values are required and that variations of other parameters alone cannot reproduce the experimental excitation functions. Asymptotic weaknesses of the statistical treatment at high excitation energies are discussed and qualitatively shown to give errors in the direction observed in the comparisons of experimental and calculated results.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 9272

9281 (ORO—3924-29, pp 1-4) **Strongly damped collisions of 197 MeV ^{12}C projectiles.** Eggers, R.; Namboodiri, M.N.; Gonthier, P.; Adler, L.; Kasiraj, P.; Natowitz, J.B. Jul 1977.

In Angular momentum effects in nuclear reactions. Progress report, August 1, 1976—July 31, 1977.

Cross sections, energy distributions, and angular distributions of the products of strongly damped collisions between 197-MeV ^{12}C projectiles and Ni, ^{89}Y, ^{159}Tb, and ^{197}Au are reported. Limiting angular momenta were derived for some of the reactions. Mass asymmetry potentials are shown. 6 figures. (RWR)

9282 (α, t) reaction in ^{45}Sc, ^{51}V, and ^{59}Co at /sup 27.2/ MeV. Tokarevskii, V.V.; Shcherbin, V.N. (Nuclear Research Institute, Ukrainian Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 255-259(Mar 1977).

Differential cross sections have been measured for (α,T) reactions in the nuclei ^{45}Sc, ^{51}V, and ^{59}Co in the respective angular regions 10—71°, 10—155°, and 10—171°. The experimental results are analyzed according to the DWBA. The possibility of an unambiguous choice of the optical potential for α particles is discussed. Values are obtained for the spectroscopic factors for the states investigated.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 9274

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

9283 Gamma rays from thermal neutron capture in ^{136}Xe. Prussin, S.G.; Lanier, R.G.; Struble, G.L.; Mann, L.G.; Schoenung, S.M. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., C;* **16**: No. 3, 1001-1009(Sep 1977).

The γ-ray spectrum following thermal neutron capture in ^{136}Xe has been studied with a Compton-suppression spectrometer. The Q value for the reaction has been measured as Q (n,γ) = 4025.5 +- 0.3 keV. Levels populated by primary transitions from the capture state correlate well with those populated by l = 1 transfers in the (d,p) and (p,p$_0$) reactions. The data indicate a strong correlation between reduced transition probabilities for the primary transitions and spectroscopic factors for final levels.

9284 Resonance neutron capture gamma-ray studies of levels in ^{145}Nd. McClure, D.A.; Raman, S.; Slaughter, G.G. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). *Phys. Rev., C;* **16**: No. 3, 1278-1281(Sep 1977).

Gamma-ray measurements have been performed on enriched ^{144}Nd targets following resonance neutron capture. The γ rays, measured with a Ge(Li) detector, have been incorporated in a level scheme for ^{145}Nd. The neutron separation energy for ^{145}Nd was determined to be 5756.9 +- 2.0 keV.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 9274

9285 Microscopic calculations of high-spin rotational states. Ma, C.W.; Rasmussen, J.O. (Cyclotron Institute and Physics Department, Texas AandM University, College Station, Texas 77843). *Phys. Rev., C;* **16**: No. 3, 1179-1195(Sep 1977).

The high-spin rotational states of ^{162}Er, ^{168}Yb, ^{174}Hf, and ^{238}U are calculated microscopically by diagonalizing the cranking Hamiltonian H-ωJ/sub x/ using both BCS and fully particle-number projected wave functions. The computational effort in the latter case is greatly reduced due to a newly derived compact formula for the residuum integral. The results show that pairing collapse does not occur in all four nuclei up to spin 20. The moderate increase of the moment of inertia at low spin is due to both higher-order cranking and Coriolis-antipairing effects. The crossing of the decoupled two-quasiparticle band with the ground band is responsible for the rapid

increase of the moment of inertia at high spin. The present calculations are able to produce the rotational energies fairly well in general, but the Nilsson single-particle levels have to be adjusted in order to reproduce the backbending behavior in ^{162}Er.

NUCLEAR REACTIONS AND SCATTERING

9286 Effect of the finite range of the nuclear force on the dynamics of fission and heavy-ion collisions. Sierk, A.J.; Nix, J.R. (W. K. Kellogg Radiation Laboratory, California Institute of Technology, Pasadena, California 91125). *Phys. Rev., C;* **16**: No. 3, 1048-1057(Sep 1977).

We study the effect on dynamical calculations of fission and heavy-ion collisions of replacing the surface energy of the liquid-drop model with a modification that takes into account the lowering of the nuclear macroscopic energy due to the finite range of the nuclear force. This energy is calculated by performing a two-dimensional volume integral over the nuclear density of a two-body attractive Yukawa potential, in analogy with the calculation of the electrostatic energy of a charge distribution. The kinetic energy of the nuclear liquid drop is calculated for incompressible, nearly irrotational hydrodynamical flow by use of the Werner-Wheeler method. The dissipation of collective energy into internal, single-particle excitation energy is neglected. In the case of fission, the liquid-drop model and finite-range model give similar results, although the liquid-drop model predicts a somewhat larger fission-fragment excitation energy. In the case of heavy-ion collisions, the surface energy of the liquid-drop model causes a large coupling of energy from relative center-of-mass motion into higher-order collective motion. This increases the energy over the one-dimensional interaction barrier that is needed to cause compound-nucleus formation in head-on collisions for symmetric systems. For an A = 250 compound system, the predicted energy over the barrier is about 170 MeV in the liquid-drop model, as compared to about 40 MeV in the finite-range model. We conclude that the effect of the finite range of the nuclear force is small in calculations of fission, but that it must be included in calculations of heavy-ion collisions.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

REFER ALSO TO CITATION(S) 9281

ENERGY LEVELS AND TRANSITIONS

9287 Determination of γ softness in ^{192} ^{194} ^{196}Pt from Coulomb excitation with ^{136}Xe projectiles. Lee, I.Y.; Cline, D.; Bulter, P.A.; Diamond, R.M.; Newton, J.O.; Simon, R.S.; Stephens, F.S. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **39**: No. 11, 684-688(12 Sep 1977).

The ^{192} ^{194} ^{196}Pt nuclei were Coulomb excited with ^{136}Xe projectiles. Strong excitation of the ground-state band (up to spin 10^+) and the "γ" band (up to spin 8^+) were observed. Excitation of the upper members of the γ band is shown to be sensitive to the γ softness. The observed Coulomb-excitation yields imply B (E2) values which follow the rigid-triaxial-rotor relation. This contradicts current calculations which predict considerable γ softness.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 9281

9288 Observation of the proton-pairing vibration in ^{208}Pb. Anderson, R.E.; Batay-Csorba, P.A.; Emigh, R.A.; Flynn, E.R.; Lind, D.A.; Smith, P.A.; Zafiratos, C.D.; DeVries, R.M. (Nuclear Physics Laboratory, Department of Physics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev. Lett.;* **39**: No. 16, 987-990(17 Oct 1977).

The (^{3}He,n) reaction was studied at an incident beam energy of 33.3 MeV for targets of ^{204}Hg and ^{204} ^{206} ^{208}Pb. A 0^+ state at 4.1 +- 0.1 MeV in ^{206}Pb was excited with 70% of the cross section of the ^{206}Pb(^{3}He,n)^{208}Po (ground state) transition. This state lies at the predicted excited energy of the proton-pairing vibration when particle-hole interactions are included.

9269 Systematics of two-neutron transfer cross sections near closed shells: A sum rule analysis of (p,t) strengths on the lead isotopes. Lanford, W.A. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev., C;* **16**: No. 3, 988-1000(Sep 1977).

We report the study of the (p,t) reaction on ^{208}Pb, ^{206}Pb, and ^{204}Pb at E = 35 MeV and on the application of the two-neutron-transfer sum rule of Bayman and Clement to these data. Analysis of the sum rule shows that the observed dramatic increase in J = 0 (p,t) cross section as one goes from targets of ^{208}Pb to ^{206}Pb to ^{204}Pb and the nearly-as-dramatic decrease in J not = 0 cross sections reflect general features of the shell-model character of these nuclei. Application to the present series of nuclei shows that this two-neutron-transfer sum rule can be applied with nearly the same accuracy as the corresponding single-nucleon-transfer sum rules. The relationship between the shell-model and pairing-vibration (p,t) strengths is discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

SPONTANEOUS AND INDUCED FISSION

9290 Energy dependence of fissionability for ^{239}Pu, ^{238}Pu, and ^{241}Am. Delagrange, H.; Lin, S.Y.; Fleury, A.; Alexander, J.M. (Centre d'Etudes nucleaires de Bordeaux-Gradignan, Laboratorie de Chimie Nucleaire, 33170 Gradignan, France). *Phys. Rev. Lett.;* **39**: No. 14, 867-870(3 Oct 1977).

Excitation-function data have been analyzed for the reactions (^{4}He, xn) with targets ^{233} ^{234} ^{235}U and ^{237}Np. Values of the neutron emission probability G/sub n/ have been extracted by comparing reaction couples (4n—3n), (3n—2n), and (2n—1n) leading to the same final products. The values of G/sub n/ for ^{235}Pu vary from 0.3 at 12 MeV to 0.1 at 20 MeV to 0.5 at 35 MeV. Similar trends are found for ^{239}Pu and ^{241}Am. Statistical-model calculations give a similar but weaker trend.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

9291 Superheavy elements: the quest in perspective. Bemis, C.E. Jr. (Oak Ridge National Lab., Tenn. (USA)); Nix, J.R. *Comments Nucl. Part. Phys.;* 7: No. 3, 65-78(May 1977).

A review is presented of the quest for superheavy elements under the following headings - early history; physical and nuclear properties unique to superheavy elements; searches in nature; terrestrial samples; extra-terrestrial samples; and searches at accelerators. 72 references.

RADIOACTIVE DECAY

9292 Half-life of thorium-232: a laboratory experiment. Chikkur, G.C.; Umakantha, N. (Department of Physics, Karnatak University, Dharwar-580 003, India). *Am. J. Phys.;* **45**: No. 11, 1120-1122(Nov 1977).

It is demonstrated that the halflife of ^{232}Th can be determined by dissolving a known amount of $Th(NO_3)_4x4H_2O$ in a liquid scintillator and using a difference method to obtain the counting rate due to isolation and particles.(AIP)

9293 Production, L x-ray identification, and decay of the nuclide ^{260}105. Bemis, C.E. Jr.; Dittner, P.F.; Silva, R.J.; Hahn, R.L.; Tarrant, J.R.; Hunt, L.D.; Hensley, D.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **16**: No. 3, 1146-1158(Sep 1977).

The nuclide ^{260}105 has been produced in the ^{249}Cf(^{15}N,4n) reaction and its decay properties investigated. The α-decay branch of 1.52 +- 0.13-sec ^{260}105 has been measured to be 90.4 +- 0.6% with spontaneous-fission decay the remainder [(9.6 +- 0.6)] . Measurement α-particle energies and intensities (% per decay) are 9.041 +- 0.014 MeV (48 +- 5), 9.074 +- 0.014 MeV (25 +- 3), and 9.120 +- 0.017 MeV (17 +- 3). Characteristic L-series x rays of element 103 were observed in coincidence with these α-particle groups, thus providing elemental identification. The ^{256}Lr α-decay daughter was observed in a direct time-correlated genetic linkage, thus providing the mass number assignment. The absence of characteristic L- or K-series x rays of element 104 in time coincidence with, but preceding, spontaneous-fission-decay events, has allowed an upper limit of 2.5% to be placed on the electron-capture decay branch of ^{260}105 to the elusive nuclide 0.1-sec ^{260}104. If ^{260}104 is a spontaneous-fission emitter with a half-life < or = 100 μsec, as some predictions would indicate, then the electron-capture decay branch of ^{260}105 is < or =0.2%.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 9293

9294 (COO—3496-63) Energy dissipation, mass diffusion and interaction times for heavy ion collisions. Huizenga, J.R.; Schroeder, W.U.; Birkelund, J.R. Wilcke, W. (Rochester Univ., N.Y. (USA)). 1977. Contract EY-76-S-02-3496. 20p. Dep. NTIS, PC A02/MF A01.

Correlations of experimental observables with kinetic energy loss and fragment mass for damped heavy ion reactions are emphasized. Angular-momentum-dependent interaction times are deduced giving a time scale for the evaluation of nucleon diffusion coefficients. The energy dissipated per nucleon exchange in Kr- and Xe-induced reactions is shown to decrease with increasing kinetic energy loss. These results are compared with predictions of a one-body dissipation mechanism and microscopic transport theory for heavy ion collisions. The relative decrease of energy dissipation due to nucleon exchange with decreasing bombarding energy is a new experimental feature that is unaccounted for by the above theories.

SPONTANEOUS AND INDUCED FISSION

9295 Search for delayed neutrons with low energies in spontaneous fission of ^{252}Cf. Piksaikin, V.M.; D'yachenko, P.P.; Laytai, A.; Semenova, N.N.; Seregina, E.A.; Kutsaeva, L.S. (Physics and Power-Engineering Institute). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 266-267(Mar 1977).

Results are reported of an experiment searching for so-called delayed neutrons with energies E/sub n/<1 MeV in spontaneous fission of ^{252}Cf. The data obtained do not support the hypothesis of existence of this type of neutron.

NUCLEAR THEORY

NUCLEAR STRUCTURE

9296 Dynamics of nuclear fluid. III. General considerations on the kinetic theory of quantum fluids. Wong, C.; McDonald, J.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **16**: No. 3, 1196-1215(Sep 1977).

From the quantum kinetic equation of Bogoliubov, Gurov, Born, and Green, the equations of motion for macroscopic variables are examined in many different ways. First, in the configuration space a hierarchy of generalized fluid-dynamical equations can be obtained by taking the appropriate limits of the quantum kinetic equation. The resultant equations of continuity, of momentum, and of energy are similar in form to those one encounters in classical fluid dynamics with the exception of additional terms proportional to h^2. Secondly, the quantum kinetic equation is examined in phase space. The same set of equations of continuity, of momentum, and of energy can be derived by taking the first three moments of the quantum kinetic equation. The exact results we obtained are utilized to form the starting point for many simplifying approximations for the investigation of the dynamics of quantum many-body systems such as the elastic response limit, the hydrodynamical limit, Landau's Fermi-liquid theory, and finally the time-dependent Hartree-Fock and the multideterminant time-dependent Hartree-Fock approximations. The fact that all these different dynamical descriptions can be traced to a common origin provides a unifying viewpoint to the present approach with the quantum kinetic equation.

9297 Spherical states in transition nuclei. Jolos, R.V.; Janssen, D. (Joint Institute for Nuclear Research). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 268-270(Mar 1977).

It is shown that in transition nuclei whose deformation potential energy depends weakly on γ, bands of spherical states can appear at comparatively low excitation energies. Expressions are obtained for the energies and degeneracy multiplicities of the states of the spherical bands. An attempt is made on the basis of the idea of spherical states to explain anomalies in the properties of states with high spins in the transition nuclei $^{190\ 192\ 194}$Pt.

9298 Method of master equations for finite open systems and its applicability in nuclear theory. Bunakov, V.E. (Leningrad Institute of Nuclear Physics, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 271-275(Mar 1977).

Master equations are deduced for finite open systems (having both continuous and discrete spectra). It is shown that these equations are valid if one uses wave packets with an energy dispersion $\Delta E > \Gamma$/sub spr/, where Γ/sub spr/ determines the rate of change of the states induced by perturbation. In the first stage of the system evolution, this rate is determined by the imaginary part of the optical-model potential; with relaxation of the system it decreases to the average width of the compound resonance. Using the obtained equations to describe nuclear reactions one can show that most of the existing phenomenological models (optical model, model of intranuclear cascade, distorted-wave method, evaporative and pre-evaporative models) may be interpreted as approximate solutions of these equations.

NUCLEAR REACTIONS AND SCATTERING

9299 (UCID—17608) NSCAT: a code to obtain charged particle nuclear (plus interference) differential scattering cross sections from experimental data. Perkins, S.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Sep 1977. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

Given the experimental charged-particle total elastic scattering differential cross section, NSCAT substracts off the Coulomb component to obtain the nuclear (plus interference) component. This report describes the equations, input, and output for the code. 1 table.

9300 Molecular-orbital interpretation of the $\Delta l = 1h$ transfer anomaly in heavy-ion reactions. Seglie, E.A.; Ascuitto, R.J. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **39**: No. 11, 688-691(12 Sep 1977).

The effect of the operator causing one-nucleon transfer in heavy-ion reactions in the molecular-orbital (MO) approach is contrasted to that of the usual distorted-wave Born approximation in a simple diffraction model calculation. For the case of $\Delta l = 1h$ transitions, it is shown that the MO approach predicts an angular distribution exactly out of phase with that of the distorted-wave Born approximation. The MO approach therefore offers a simple explanation of the "anomalous" angular distributions recently observed.

9301 Isospin symmetry-breaking in compound and precompound nuclear reactions. Feinstein, R.L. (The Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen O, Denmark). *Ann. Phys. (N.Y.);* **107**: No. 1, 222-265(6 Sep 1977).

The preequilibrium formalism of the Unified Theory of Nuclear Reactions serves as the formal framework for studying the consequence of isospin symmetry-breaking. A T-violating generalization of the energy-average fluctuation cross section is obtained by (a) choosing a "chained-partition" representation of the closed-channel Hilbert space, from the "simple" doorway through subspaces of increasing "complexity," (b) introducing explicitly the symmetry-breaking component of the A-body Hamiltonian, (c) following its effects through the entire formal framework, and (d) applying standard statistical approximations. An isospin-conversion mechanism emerges in an explicit microscopic representation. Its functional relationship to the mean isospin-mixing interaction strength is realized by performing an approximate diagonalization of a realistic subspace and by employing random matrix theory. Our analysis suggest that near "complete" mixing is common in compound as well as some precompound processes and that its energy dependence can be very rapid. Simplifications of the general formula are noted. One by-product is the T-violating version of the Hauser—Feshbach expression involving a single mixing parameter. The relationship of this parameter to the mixing interaction strength is precisely clarified, and an approximate analytic relation is provided. Employing an extended exciton model with isospin properly incorporated, the statistical theory is applied to a comparative study of the photoalpha-particle reactions ^{28}Si(γ, α_0)^{24}Mg and ^{30}Si(γ, α_0)^{26}Mg in their giant dipole resonance regions. Although the former is isospin-forbidden, its energy-integrated experimental cross section is about twice that of the latter which is isospin-allowed. This discrepancy is explained.

9302 Interaction of K^+ mesons with nuclei. Dover, C.B.; Moffa, P.J. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **16**: No. 3, 1087-1096(Sep 1977).

We investigate the general features of K^+ meson interactions with nucleons and nuclei. A first-order optical potential is constructed, and used to predict K^+ total elastic and reaction cross sections on typical nuclei in the low-energy domain (p/sub lab/ < or = 800 MeV/c). The sensitivity of these cross sections to changes in the nuclear radius and surface thickness is explored. Comparisons with the available K^+-emulsion data are made. We emphasize that a low-energy K^+ is the only available strongly interacting hadron which is weakly absorbed in nuclei (mean free path $\simeq$ 7 fm). This makes it an appealingly simple probe for nuclear structure studies.

9303 Angular correlations of gamma rays and charged particles, and direct reaction mechanisms which include delay. Zelenskaya, N.S. (Nuclear Physics Institute, Moscow State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 276-279(Mar 1977).

Delay effects are included in the inelastic scattering of α particles by even-even nuclei when the interaction is described by a rectangular diagram. This enables one to account for the rapid change in the symmetry angle of the angular correlation function for inelastically scattered α particles and gamma rays emitted by the excited nucleus. The agreement with experiment is good.

9304 Investigation of two-neutron-emission reactions in the model of semidirect processes (pre-equilibrium emission). Ol'khovskii, V.S.; Plyuiko, V.A. (Kiev State University). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 279-282(Mar 1977).

An expression is constructed for the cross sections of reactions of the type (n,2n) for pre-equilibrium emission of the particles. The excitation functions of the (n,2n) reaction are calculated for four nuclei and comparison is made with experiment.

9305 Measurement and calculation of excitation functions for (n,p) reactions in nuclei with Z> or =48 for E/sub n/≅10—20 MeV. Belovitskii, G.E. (Institute for Nuclear Research, Academy of Sciences of the USSR). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 282-285(Mar 1977).

The energy dependence of the (n,p) -reaction cross section is calculated in the exciton model for eight nuclei with Z> or =48. Good agreement is observed between the calculation and experiment. A method is proposed for determining σ/sub n p/ in a wide range of neutron energies E/sub n/ from measurements on two nuclei with similar Z in a narrow range of E/sub n/.

9306 New approach to the three (and more) -body problem. Kirzhnits, D.A.; Takibaev, N.Z. (P. N. Lebedev Institute of Physics, USSR Academy of Sciences). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 370-376(Mar 1977).

A method is presented to describe a quantum few-body system, based on the law of its evolution with change of the coupling constant. The corresponding equations lead to the scattering matrix, which is unitary at any stage of the successive approximations. The method is applied to the neutron-deuteron quartet scattering below the deuteron breakup threshold. Even in the lowest approximation of the method, simple analytical expressions arise for the scattering phase shifts; they are in good agreement with experiment. The contribution from the next approximation is lower by an order of magnitude.

RADIOACTIVE DECAY

9307 K capture in a strong magnetic field. Oraevskii, V.N.; Rez, A.I.; Semikoz, V.B. (Scientific-Industrial Union "Energy"). *Sov. J. Nucl. Phys. (Engl. Transl.);* **25**: No. 3, 377-378(Mar 1977).

The increase in the probability of K capture in the presence of a magnetic field is calculated explicitly. The dependence on the nuclear charge is also computed.(AIP)

9308 New type of radioactive decay: gravitational annihilation of baryons. Zel'dovich, Y.B. (Institute for Applied Mathematics, USSR Academy of Sciences, Moscow). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 9-11(Jan 1977).

Some considerations are presented in favor of baryon-number nonconservation at the elementary particle level if the strong gravitational interaction at short distances is taken into account. A rough and unreliable estimate is given for the decay time of nuclei according to this mechanism.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 8784, 8996

9309 (BNWL—2254) **Method for calculating single-event distributions for point source alpha emitters.** Wilson, W.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-06-1830. 23p. Dep. NTIS, PC A02/MF A01.

A method is described for calculating single-event distributions for point-source alpha emitters. The method is based on computer simulation of alpha particle track structure by Monte Carlo techniques. 4 figures.

9310 (ORNL—5171, pp 173-201) **General physics and surface interactions.** Ritchie, R.H.; Anderson, V.E.; Ashley, J.C. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Research in general physics and surface interactions is reported. Topics covered include: pion beam dosimetry; electron slowing-down spectra in Al_2O_3; a statistical approach to the evaluation of electron inelastic mean free path and energy loss in solids; electron slowing-down spectra in aluminum metal due to low-energy sources; tabulations of electron interaction parameters in solids; energy losses by slow ions to electronic excitations in solids; the interaction of slow ions and atoms with surfaces; spatial representation of swift electron interactions in matter; the image potential of a point charge in the neighborhood of a cylinder; the wake potential of swift ions in solids; electron capture and loss by a swift ion in condensed media; excitation of surface plasmons on spherical voids in a metal by fast electrons; the energy and spatial dependence of swift electrons transmitted through thin solid films; total reflection calculations; and the minimum dipole moment required to bind an electron-discovery of an unpublished solution by Fermi. (GHT)

9311 (ORNL—5171, pp 229-239) **Microdosimetry, biological modeling, and theoretical biophysics.** Wright, H.A.; Garrett, W.R.; Hamm, R.N.; Neufeld, J.; Payne, M.G.; Ritchie, R.H.; Todd, P.W.; Turner, J.E.; Turner, T.P. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

Microdosimetry research is reported. Monte Carlo calculation of the transport of electrons through liquid water; proposed modifications of the cell survival theory of Katz; a method for calculating cellular inactivation cross sections; and relations between low-LET cell-survival models having different inactivation mechanisms are covered. (GHT)

9312 Electron slowing-down flux spectrum in Al_2O_3. Tung, C.J.; Ashley, J.C.; Birkhoff, R.D.; Ritchie, R.H.; Emerson, L.C.; Anderson, V.E. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **16**: No. 7, 3049-3055(1 Oct 1977).

An electron slowing-down flux spectrum has been measured for β particles, δ rays, and secondaries generated by the β decay of neutron-activated ^{164}Dy uniformly distributed in Al_2O_3. The energy range covered in these measurements extends from 1.5 to 32 keV. Fairly good agreement with predictions of the Spencer-Fano theory is found for energies above 10 keV. The overall shape of the spectrum is similar to that found earlier for metals and semiconductors. A companion theoretical calculation has been carried out based on cross sections for ionization of electrons from the inner shells of Al and O derived from generalized oscillator strengths, and on cross sections for valence-band electrons derived from a model-insulator theory. The effect of Auger cascade electrons is also included in the numerical solution of the electron slowing-down cascade equation. The theoretical spectra are smaller than the experimental results by as much as a factor of 4 in the energy range from 50 to 2000 eV.

SHIELDING CALCULATIONS AND EXPERIMENTS

9313 (UCRL—79759) **Applications of the probability table method to practical problems.** Plechaty, E.F.; Cullen, D.E.; Levitt, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. Contract W-7405-ENG-48. 9p. (CONF-771109—41). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

The objective of using the probability table method (PTM) was to use a continuous-energy Monte Carlo code in which the cross sections are given as multigroup constants and yet to account for self-shielding within each group. In order to achieve this objective, the PTM was extended to deterministic methods. The ALICE Monte Carle Neutron Transport Code uses the PTM for all 175 energy groups which span the energy range from thermal to 20 MeV. The TART, ALICE, and MCN codes were used to determine the critical radius of a sphere of UH_3, where the U^{235} enrichment varied from 20 to 100%. The PTM was used to calculate the transmission through a 30 cm iron plate. The source was normal to the slab and distributed as 1.0/E from 20.0 MeV to 1 keV. For the problems investigated the ALICE code can calculate both shielding and criticality problems as accurately as the pointwise code MCN. 1 figure, 1 table. (RWR)

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 8435, 8436

9314 (KFK—2387/III) **KEDAK program compendium. Pt. 3. KEDAK data retrieval.** Stein, E.; Krieg, B.; Langner, I.; Meyer, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). 1977. 196p. Dep. NTIS (US Sales Only), PC A09/MF A01.

All data retrieval packages available for the direct access representation of KEDAK will be described in this part of the Compendium. Both the basic access programs, which retrieve one data item per access, and the user oriented programs, which retrieve, by using the basic programs, a set of data items, will be presented. Besides the detailed description also a general introduction to the KEDAK data retrieval will be given.

9315 (LA—6865-MS) **Evaluation of three Monte Carlo estimation schemes for flux at a point.** Kalli, H.J.; Cashwell, E.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 24p. Dep. NTIS, PC A02/MF A01.

Three Monte Carlo estimation schemes were studied to avoid the difficulties caused by the $(1/r^2)$ singularity in the expression of the normal next-event estimator (NEE) for the flux at a point. A new, fast, once-more collided flux estimator (OMCFE) scheme, based on a very simple probability density function (p.d.f.) of the distance to collision in the selection of the intermediate collision points, is proposed. This kind of p.d.f. of the collision distance is used in two nonanalog schemes using the NEE. In these two schemes, which have principal similarities to some schemes proposed earlier in the literature, the $(1/r^2)$ singularity is canceled by incorporating the singularity into the p.d.f. of the collision points. This is

achieved by playing a suitable nonanalog game in the neighborhood of the detector points. The three schemes were tested in a monoenergetic, homogeneous infinite-medium problem, then were evaluated in a point-cross-section problem by using the Monte Carlo code MCNG. 10 figures.

9316 (UCRL—79761) **Calculation of probability table parameters to include intermediate resonance self-shielding.** Cullen, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. Contract W-7405-ENG-48. 9p. (CONF-771109—8). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

In order to demonstrate the practicality of the multi-band method [Cullen, Nucl. Sc. Eng., 55, 387 (1974)] as applied to all energy ranges, it is demonstrated that intermediate resonance effects may be included; usually only two or three, and at most four, bands are required in any cross section probability table; and a low-order rational approximation is an excellent means of defining Bonderenko sigma$_0$ self-shielded cross sections. 1 table.

9317 **Neutron slowing down and transport in a medium of constant cross section. I. Spatial moments.** Cacuci, D.G.; Goldstein, H. (Department of Mechanical and Nuclear Engineering, Columbia University, New York, New York 10027). *J. Math. Phys. (N.Y.);* **18**: No. 12, 2436-2444(Dec 1977).

Some aspects of the problem of neutron slowing down and transport have been investigated in an infinite medium consisting of a single nuclide scattering elastically and isotropically without absorption and with energy-independent cross sections. The method of singular eigenfunctions has been applied to the Boltzmann equation governing the Laplace transform (with respect to the lethargy variable) of the neutron flux. Formulas have been obtained for the lethargy dependent spatial moments of the scalar flux applicable in the limit of large lethargy. In deriving these formulas, use has been made of the well-known connection between the spatial moments of the Laplace-transformed scalar flux and the moments of the flux in the "eigenvalue space." The calculations have been greatly aided by the construction of a closed general expression for these "eigenvalue space" moments. Extensive use has also been made of the methods of combinatorial analysis and of computer evaluation, via FORMAC, of complicated sequences of manipulations. It has been possible to obtain for materials of any atomic weight explicit corrections to the age theory formulas for the spatial moments M/sub 2n/(u), of the scalar flux, valid through terms of order of u^{-5}. Higher order correction terms could be obtained at the expense of additional computer time. The evaluation of the coefficients of the powers of n, as explicit functions of the nuclear mass, represent the end product of this investigation.

DOSIMETRY

REFER ALSO TO CITATION(S) 9080, 9081, 9085, 9086, 9087

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 8774, 8804, 9343

9318 (LA—6859-MS) **Polymorphic detonation.** Fickett, W. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-36. 20p. Dep. NTIS, PC A02/MF A01.

The steady detonation whose driving force is the volume change in a polymorphic phase transition is discussed. The problem is simplified by using an idealized equation of state for which the pressure depends on the density and composition, but not on the internal energy. Both the inviscid and viscid cases are treated. The phase transition may be represented schematically as A_1 reversible A_2, lambda = 0$_1$ 1, with A_2 the lower density phase and lambda the transformation progress variable (mass fraction of phase 2). The initial state for the detonation is pure phase 1 (lambda = 0) in a metastable state well below the transition pressure. Possible examples are stishovite—quartz, diamond—carbon, and wate—ice, with initial states metastable stishovite, metastable diamond, and supercooled water, respectively. Different wave structures are found, including double waves in which a decoupled transformation zone moves more slowly than the shock. 13 figures, 1 table.

9319 (ORNL/CSD—26) **Applicability and extendability of Megerlin's method solving parabolic free boundary problems.** Solomon, A. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 43p. Dep. NTIS, PC A03/MF A01.

The applicability of an analytical approximation procedure of F. Megerlin to a number of free-boundary problems is examined. A method for extending the Megerlin procedure to a convergent approximation technique is indicated, its convergence for a particular family of problems is proved, and its implementation is exhibited. 6 tables.

9320 **Statistical theory of dislocation configurations in a random array of point obstacles.** Labusch, R. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **48**: No. 11, 4550-4556(Nov 1977).

The stable configurations of a dislocation in an infinite random array of point obstacles are analyzed using the mathematical methods of statistical mechanics. The theory provides exact distribution functions of the forces on pinning points and of the link lengths between points on the line. The expected number of stable configurations is a function of the applied stress. This number drops to zero at the critical stress. Due to a degeneracy problem in the line count, the value of the flow stress cannot be determined rigorously, but we can give a good approximation that is very close to the empirical value.

9321 **Electronic structure and lattice instability of metallic VO_2** . Gupta, M.; Freeman, A.J.; Ellis, D.E. (Physics Department and Materials Research Center, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B;* **16**: No. 8, 3338-3351(15 Oct 1977).

A first-principles energy-band study of the metallic rutile phase of VO_2 using a general crystal potential and an expansion of the Bloch functions in a linear combination of atomic orbitals is reported. The results are compared with previous work and experimental optical, x-ray absorption and emission, and x-ray photoelectron spectroscopy data. We obtain a large density of states at the Fermi energy; the Fermi surface is found to be determined by the two lowest d bands, at the bottom of the "t/sub 2g/" manifold which is split by the orthorhombic field; the lowest-band Fermi surface possesses some nesting features corresponding to a nesting vector q = ΓR. A calculation of the generalized susceptibility in the constant—matrix-element approximation shows the existence of a maximum at the zone boundary R. We suggest that the formation of a charge-density wave with wave vector q = ΓR accompanied by a periodic lattice distortion is thus possible; the subsequent condensation of phonons at the point R could then explain the crystallographic phase transition observed at T = 339 K.

9322 **Cluster motion on surfaces: A stochastic model.** Landman, U.; Shlesinger, M.F. (Department of Physics and Astronomy, Institute of Fundamental Studies, University of Rochester, Rochester, New York 14627). *Phys. Rev., B;* **16**: No. 8, 3389-3405(15 Oct 1977).

A stochastic model of the diffusion of clusters on crystalline surfaces is presented. The cluster configurations are mapped onto a periodic lattice with internal states. The formulation is capable of treating complex kinetics, cluster structures, and surface topologies. A detailed analysis of dimers with two and three allowable states in one and two dimensions is given. These correspond to recent observations of the diffusion of atomic clusters on surfaces by field-ion microscopy techniques. Expressions for the transition rates between spatial configurations involved in the motion of the clusters are derived in terms of experimental observables. It is demonstrated that for a complete determination of the parameters characterizing the various cluster configurations (i.e., activation energies and frequency factors) full use of the field-ion microscope data (moments of the cluster centroid displacement and equilibrium state occupation probabilities) is required. The effect of a bias field is included in our analysis, and shown to be essential in certain cases for a complete determination of the transition rates. The effect of periodically placed defects on the diffusion on surfaces is investigated.

9323 **Improved numerical results for the three-dimensional alloy with site diagonal disorder.** Alben, R.; Blume, M.; McKeown, M. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). *Phys. Rev., B;* **16**: No. 8, 3829(15 Oct 1977).

Densities of states are obtained for ~ 10 000-atom three-dimensional alloy models with site-diagonal disorder, and the results are compared with the single-site coherent-potential approximation. The numerical approach contains several improvements over our previous calculations.

9324 **Low-temperature spin-wave dynamics in three-component classical Heisenberg chains.** Heller, P.; Blume, M. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev. Lett.;* **39**: No. 15, 962-965(10 Oct 1977).

A detailed quantitative study of the low-temperature spin-wave dynamics has been made for the classical Heisenberg-coupled chain using computer simulation. Results for the relaxation rates are presented and compared with dynamic scaling and other predictions.

9325 **Polarization analysis of emission lines in the presence of relaxation.** Banerjee, S.; Blume, M. (Department of Physics, State University of New York, Stony Brook, New York 11794). *Phys. Rev., B;* **16**: No. 7, 3061-3069(1 Oct 1977).

A general expression is given for the polarization density matrix of electromagnetic radiation emitted in the presence of fluctuating surroundings. This has been utilized to compute numerically the polarization state of the entire emission line within the framework of various stochastic models. It is concluded that polarization

analysis of the Moessbauer lines can be a useful tool for the exploration of the hyperfine interactions and relaxation phenomena.

9326 Direction of the black—white contrast of dislocation loops. Ohr, S.M. (Oak Ridge National Lab., TN). *Phys. Status Solidi (a);* **38**: 553-557(1976).

The electron microscope image contrast of dislocation loops under two-beam dynamical diffraction conditions is calculated using the Howie-Whelan equations and the displacement fields of the dislocation loops of pure edge, as well as shear, orientation in an infinite isotropic medium. The results indicate that the deviation of the black-white direction, measured from the diffraction vector, is directly proportional to the sum of the deviations of Burgers vector and loop normal projected onto the image plane. The rule governing the black-white direction, which is also consistent with first-order analytical theories of image contrast, will be useful in determining the crystallographic nature of dislocation loops from contrast analysis.

SUPERCONDUCTIVITY

GENERAL THEORY

9327 Electromagnetic properties of "dirty" superconductors in strong high-frequency fields. Genkin, V.M. (Gor'kii Scientific-Research Radio Physics Institute). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **3**: No. 3, 139-142(Mar 1977).

The electromagnetic properties of "dirty" superconductors with nonmagnetic impurities are investigated theoretically in strong high-frequency fields. It is shown that the dissipative part of the conductivity $\sigma_1(\omega)$ in a strong field of frequency ω_0 has a singularity of the form $1/\omega$ for ωvery-much-less-than$\omega_0 < 2\Delta$ and is negative at zero temperature. The sign of $\sigma_1(\omega)$ becomes positive with an increase in temperature. Both $\sigma_1(\omega)$ at $\omega_0$very-much-less-than$\omega < 2\Delta$ and $\sigma_2(\omega)$ at ωvery-much-less-than$\omega_0$very-much-less-than2Δ, $(T=0)$ are calculated.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 8767

9328 Mechanical properties of a chain of superconducting rings containing a frozen-in magnetic flux. Shikina, N.I. (Institute of Solid-State Physics, Academy of Sciences of the USSR). *Sov. J. Low Temp. Phys. (Engl. Transl.);* **3**: No. 3, 184-185(Mar 1977).

It is shown that one-dimensional and two-dimensional chains composed of linked superconducting rings with "frozen in" magnetic flux acquire the property of changing their length elastically.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

9329 (UCID—17611) **HONDO code upgrade.** Young, R.W.; Hallquist, J.O.; Goudreau, G.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 61p. Dep. NTIS, PC A04/MF A01.

Lawrence Livermore Laboratory has added a contact-impact algorithm to a finite-element code used by the United States Army Engineer Waterways Experiment Station. As now structured, the code can solve problems with material interfaces that slide but do not penetrate; tied material interfaces that do not slide but allow unequal zoning across the interface; material interfaces with voids that open or close, and with sliding contact either with or without friction; and intersecting material interfaces with any combination of the properties stated above. This report provides the information needed by users of the contact-impact algorithm. Results from three numerical examples are included to illustrate the effect of varying the level of interface restraint. 42 figures.

9330 Finite and infinite measurement sequences in quantum mechanics and randomness: The Everett interpretation. Benioff, P.A. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Math. Phys. (N.Y.);* **18**: No. 12, 2289-2295(Dec 1977).

The quantum mechanical description of both a finite and infinite number of measurement repetitions, as interactions between copies of an object system and a record system, are considered here. States describing the asymptotic situation of an infinite number of repetitions are seen to have some interesting properties. The main construction of the paper is the association of states to sequential tests for randomness. To each such test T and each positive integer m one can associate states Θ/sub n//sup T m/ and Θ/sup infinityT m/ corresponding respectively to those length-n and finite outcome sequences which pass test T at the significance level 2/sup -m/. Following the methods of Martin Loef, a universal sequential test V, which includes an infinity of sequential statistical tests for randomness, is given and the corresponding states Θ/sub n//sup V m/ and Θ/sup infinityV m/ are discussed. Finally, a possible use of these states in the Everett interpretation of quantum mechanics is discussed.

9331 Casimir invariants and vector operators in simple and classical Lie algebras. Okubo, S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *J. Math. Phys. (N.Y.);* **18**: No. 12, 2382-2394(Dec 1977).

A method of computing eigenvalues of certain types of Casimir invariants has been developed for simple and classical Lie algebras. Especially these eigenvalues for algebras A/sub n/, B/sub n/, C/sub n/, D/sub n/, and G_2 have been computed in closed terms. We also enumerate numbers and functional forms of all linearly independent vector operators in terms of generators in any irreducible representation of these algebras. Some polynomial identities among infinitesimal generators of these algebras are derived by means of the same technique.

9332 Time dependent canonical transformations and the symmetry-equals-invariant theorem. Cary, J.R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Math. Phys. (N.Y.);* **18**: No. 12, 2432-2435(Dec 1977).

Expressions for the remainder function of a time dependent infinitesimally generated canonical transformation have recently been found by Dewar, who considered the action of the transformation operators on Liouville's equation. Here an alternate proof of the remainder function expression is given, based on the transformations of particle trajectories. Then, using this expression, a proof of the symmetry-equals-invariant theorem is given.

9333 Transport approach to one-dimensional quantum scattering. Tikochinsky, Y. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Am. J. Phys.;* **45**: No. 11, 1091-1093(Nov 1977).

Starting from "first principles," transport and invariant imbedding equations are derived for one-dimensional quantum scattering. The connection between the two kinds of equations is established by means of a simple transformation.

9334 Relativistic quantum Hamiltonian formulation for a system of directly interacting particles. Sokolov, S.N. (Institute of High-Energy Physics, Protvino, Moscow Region). *Sov. Phys. - Dokl. (Engl. Transl.);* **22**: No. 4, 198-200(Apr 1977).

The general quantum solution of Dirac's problem is given for a system of directly interacting particles where the number of particles may be either constant or variable. (AIP)

RELATIVITY AND GRAVITATION

9335 (N—77-22029) **Techniques of global analysis applied to gravitation theories: a cosmological black hole.** Debney, G. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Feb 1977. 19p. (NASA-TM-X—73378). NTIS PC A02/MF A01.

An elementary model of freely falling observers and emitters within a black hole's radius is examined to determine the redshift spectrum reaching a typical observer. The model is independent of scale, the fundamental unit being the radius (mass) of the black hole. The observers/emitters all follow the same kinds of trajectories: radially inward and starting from rest at spatial infinity. The test-particle role is assumed throughout; i.e., the observers/emitters do not themselves contribute to the gravitational field of the system. By means of redshift formulas and luminosity distance to the emitters, a picture of actual redshifts and blueshifts, with their intensities, emerges for an observer within the black hole's radius. No luminosity distances greater than approximately one-half the radius are considered in this particular study; nevertheless, redshifts and blueshifts up to approximately 0.6 are seen in portions of the observer's celestial sphere. An exotic application can be made, as a curiosity, to a black hole the size of the universe, resulting in a particular anisotropic cosmology.

9336 General relativity and cosmology. Sachs, R.K.; Wu, H. *Bull. Am. Math. Soc.;* **83**: No. 6, 1101-1164(Nov 1977).

A broad survey of the mathematics of general relativity theory is presented. Among the topics covered are Einstein field equations, cosmological models, black holes, space-times, and electromagnetism.(AIP)

OPTICS

REFER ALSO TO CITATION(S) 9173

9337 Relaxation oscillations in stimulated Raman scattering. Kachen, G.I.; Lowdermilk, W.H. (Lawrence Livermore Laborato-

ry, University of California, Livermore, California 94550). *Phys. Rev., A;* **16**: No. 4, 1657-1664(Oct 1977).

Light pulses created by stimulated Raman scattering having been found to exhibit a complex time dependence which resembles relaxation oscillations. A focused laser pulse generated both forward and backward Raman emissions which appeared as a series of pulses with durations much shorter than the incident laser pulse. Time dependence of the Raman emission was observed directly by use of a streak camera. The number of observed pulses increased with the intensity of the incident pulse, while separation of the pulses in time depended on the length of the focal region. Beam focusing was incorporated in the coupled wave equations for stimulated Raman scattering. These rate equations were then solved numerically, and the results are in good qualitative agreement with the experimental observations. The short Raman pulses are created by a process associated with depletion of the incident laser pulse. This process occurs under a broad range of conditions.

9338 Space-bandwidth product of some deblurring filters. Hansche, B.D. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Appl. Opt.;* **16**: No. 9, 2550-2553(Sep 1977).

We present an estimate of the space-bandwidth product of a filter of the form W (f) =H (f)]/[H²(f)+C (f)], which is often encountered in image processing. The estimate applies to blur functions H (f) which are similar to the linear motion blur in that they oscillate smoothly under a decreasing envelope.

STATISTICAL PHYSICS AND THERMODYNAMICS

9339 Time-dependent Hartree approximation for a one-dimensional system of bosons with attractive δ-function interactions. Yoon, B.; Negele, J.W. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., A;* **16**: No. 4, 1451-1457(Oct 1977).

The time-dependent Hartree approximation is compared with an exact solution for the scattering between two N-particle bound states in the case of a 1-dimensional system of bosons with attractive δ-function interactions. It is shown that to leading order in N, the approximation is exact, and arguments are presented relating this asymptotic agreement to the nonsaturation of the bound states.

9340 Structure of a liquid—vapor interface. Kalos, M.H.; Percus, J.K.; Rao, M. (Courant Institute of Mathematical Sciences, New York University, New York, New York). *J. Stat. Phys.;* **17**: No. 3, 111-136(Sep 1977).

The structure of the interface of an argonlike fluid in equilibrium with its own vapor at low temperature is studied using molecular dynamics. The longitudinal pair correlations in the interface are found to be consistent with a simply defined ensemble of local thermodynamic states. However, the transverse correlations exhibit very long-range behavior not predicted by straightforward local thermodynamics. These results strongly suggest that the interface is made up of an ensemble of configurations in each of which the transition from liquid to vapor is locally sharp, but that the transition surface fluctuates strongly in space and time.

ELECTRICITY AND MAGNETISM

REFER ALSO TO CITATION(S) 9342

9341 Possibility of creating an electromagnetic tachyon by ultrashort laser pulses. Faingol'd, M.I. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 4, 130-131(Apr 1977).

The possibility of producing and detecting tachyons is discussed. The method considered is the reflection of wave packets of laser radiation.(AIP)

MATHEMATICAL PHYSICS

9342 (UCID—17502(Rev.1)) **Prony's method for the angle domain.** Miller, E.K.; Lager, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Oct 1977. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

Prony's method, a technique for obtaining the parameters of a series of complex exponentials, is used here to analyze the radiation pattern of a linear array of isotropic radiators. The locations and amplitudes of the radiators are derivable from the pattern. Possible applications include imaging and array synthesis. 4 figures, 2 tables.

9343 Correlation between crystallographic computing and artificial intelligence research. Feigenbaum, E.A. (Stanford Univ., CA); Engelmore, R.S.; Johnson, C.K. *Acta Crystallogr., Sect. A;* **33**: 13-18(1977).

Artificial intelligence research, as a part of computer science, has produced a variety of programs of experimental and applications interest: programs for scientific inference, chemical synthesis, planning robot control, extraction of meaning from English sentences, speech understanding, interpretation of visual images, and so on. The symbolic manipulation techniques used in artificial intelligence provide a framework for analyzing and coding the knowledge base of a problem independently of an algorithmic implementation. A possible application of artificial intelligence methodology to protein crystallography is described. 2 figures, 2 tables.

COMMUNICATION, EDUCATION, HISTORY, AND PHILOSOPHY

9344 (PUB—113(Vol.2)) **Travels in the new world. Volume II.** Seaborg, G.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1977. Contract W-7405-ENG-48. 719p. Dep. NTIS, PC A99/MF A01.

This is the second volume of a three-volume series, Travels in the New World, an account of the visits of Glenn T. Seaborg to 60 countries during his tenure as Chairman of the U. S. Atomic Energy Commission during the decade 1961—1971. This volume includes 18 chapters describing, on a trip-by-trip, rather than country-by-country, basis, visits to some 40-odd countries. Some narrative material is interspersed in order to help the reader understand the journal entries. Although much of the focus of the book is on the peaceful uses of nuclear energy throughout the world, there is also much emphasis on the role of science and technology in furthering the growth and development of the countries visited. A theme throughout is the effort in numerous countries to promulgate the Non-Proliferation Treaty (NPT), in order to prevent or minimize the spread of nuclear weapons capability.

FUSION ENERGY

9345 Technology index. Volume 11, No. 8, 1977. Bibliography, author index, subject index, appendix. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1977). 56p.

This bibliography contains 330 references on various aspects of controlled fusion research. Subject and author indexes are included. (MOW)

PLASMA RESEARCH

REFER ALSO TO CITATION(S) 9516

PLASMA CONFINEMENT AND HEATING

9346 (CEA-CONF—3736) **Ion measurements during lower hybrid experiments in Wega.** Lallia, P.P.; Pacher, G.W.; Pacher, H.D. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 16p. (CONF-760958—11). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. international symposium of plasma physics on heating in torodial devices; Varenna, Italy (6 Sep 1976).

The R.F. heating experiments in the WEGA Tokamak at the lower hybrid resonance (LHR) frequency are presented with special emphasis on the ion measurements by charge exchange analysis. The application of R.F. always results in a hot ion tail which could absorb much of the R.F. power because of its short lifetime. An increase of 20-30% of the bulk ion temperature has been observed during the R.F. pulse. The ion temperature decays in several milliseconds, as measured by two independent diagnostics.

9347 (N—77-21970) **Ohmic plasma heating by magnetic field-aligned currents in an internal ring configuration.** Ohlsson, D. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Jun 1976. 23p. (TRITA-EPP—76-15). NTIS PC A02/MF A01.

Ohmic heating of a plasma confined by a poloidal magnetic field and impermeable to neutral gas was investigated. The time dependent macroscopic fluid equations were solved numerically by using a combination of an implicit and an explicit method. The plasma loss mechanisms were assumed to be of classical origin but anomalous effects could be simulated by introducing certain numerical factors. The heat losses along the magnetic field lines due to incomplete magnetic shielding of the internal ring supports were considered in terms of a single-particle model. The possibilities of a pinching of the heating current resulting in a thermal instability are discussed, as well as various stabilizing mechanisms.

9348 Energy measurements on fast-pulsed near-relativistic electron beams using bremsstrahlung absorption spectroscopy. Smith,

A.C. Jr.; Swannack, C.E.; Fleischmann, H.H.; Schrandt, R.G.; Thompson, W.L. (Schools of Applied and Engineering Physics and Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Rev. Sci. Instrum.;* **48**: No. 12, 1610-1616(Dec 1977).

The paper describes a technique for measuring the average energy: and its temporal changes: of intense electron beams on time scales down to a few nanoseconds using 3-channel absorption spectroscopy of the bremsstrahlung from a thin target. The technique appears useful for reasonably monoenergetic electron beams in the energy range of 200—800 keV.

9349 Some effects of end stoppering on a theta-pinch plasma. Dixon, R.H.; Elton, R.C.; Griem, H.R. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **20**: No. 11, 1954-1955(Nov 1977).

Experimental data are presented indicating improved homogeneity and stability of the luminous plasma in a hard core θ-pinch device equipped with quartz end-stopper disks.

9350 Resonance absorption of 1.06-μm laser radiation in laser-generated plasma. Balmer, J.E.; Donaldson, T.P. (Institute of Applied Physics, University of Berne, CH-3012 Berne, Switzerland). *Phys. Rev. Lett.;* **39**: No. 17, 1084-1087(24 Oct 1977).

The electron temperature of plasma generated by 35-psec 1.06-μm laser pulses, focused onto perspex targets, has been measured as a function of laser polarization and incidence angle. These measurements demonstrate that resonance absorption contributes significantly to the total absorption of obliquely incident laser radiation. The relative magnitudes of resonance and classical absorption have been measured together with the density of "hot electrons" heated by the resonance process.

9351 Properties of electrostatic ion-cyclotron waves in a mirror machine. Turner, W.C.; Powers, E.J.; Simonen, T.C. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev. Lett.;* **39**: No. 17, 1087-1091(24 Oct 1977).

Frequency and wavelength of electrostatic ion-cyclotron waves have been measured in a mirror machine. The dominant frequency occurs near the ion-cyclotron fundamental with width $\Delta f/f < 0.02$. For most of the plasma buildup and decay the perpendicular wave numbers are consistent with an ion-diamagnetic drift wave ω/sub i/* = k/sub perpendicular(c Ei-italic//cB)(1/n) dn/dx at the ion-cyclotron frequency. With increasing wave amplitude the wave spectral properties do not change but an increase in ion energy diffusion is observed, supporting a wave-particle saturation of the mode.

9352 Plasma rotation during implosion in a θ pinch. Bengtson, R.D.; Eckstrand, S.A.; Sgro, A.G.; Nielson, C.W. (Department of Physics, The University of Texas at Austin, Austin, Texas 78712). *Phys. Rev. Lett.;* **39**: No. 14, 884-888(3 Oct 1977).

A differential rotation of a collisionless θ-pinch column during implosion has been observed and explained by a model in which the driving mechanism is the off-diagonal element p/sub r theta/of the pressure tensor. Rotational motion was detected by directional probes and spectroscopic techniques. Experimental data were modeled by a one-dimensional hybride code which included ionization and chrge exchange of protons with neutral H atoms.

9353 Turbulent temperature fluctuations in the Princeton Large Tokamak plasma. Arunasalam, V.; Cano, R.; Hosea, J.C.; Mazzucato, E. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **39**: No. 14, 888-891(3 Oct 1977).

We present the first experimental evidence for the existence of turbulent temperature fluctuations in plasmas. These measurements were accomplished by a spectral analysis of backbody electron cyclotron emission. The fractional fluctuation in the mean electron energy is up to 10% for typical Princeton Large Tokamak discharges. The spectrum of temperature turbulence extends well beyond the electron diamagnetic-drift frequency f/sub asterisk/and shows no resemblance to the simultaneously existing turbulent density fluctuations.

9354 Quantum-statistical models for multicomponent plasmas. II. Rozsnyai, B.F. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., A;* **16**: No. 4, 1687-1691(Oct 1977).

The Thomas-Fermi-Dirac statistical model and one that adds a Debye-Hueckel interaction between particles is used to compute the Gibbs potential for mixtures. It is found that, in certain cases, the two models have different predictions with respect to phase separation. Calculations are presented for the mixtures of iron and hydrogen under astrophysical conditions.

9355 Alfven-wave heating experiment in the heliotron-D. Obiki, T.; Mutoh, T.; Adachi, S.; Sasaki, A.; Iiyoshi, A.; Uo, K. (Plasma Physics Laboratory, Kyoto University, Uji, Japan). *Phys. Rev. Lett.;* **39**: No. 13, 812-815(26 Sep 1977).

Plasma heating experiment is performed using a low-frequency shear Alfven wave in the Heliotron-D device. The excitation of the wave is confirmed, and an efficient plasma heating is observed; electrons are heated up to about 2 times and ions more than 1.5 times of the initial temperatures by applying an rf pulse of 400-kW power level.

9356 Nonlinear dynamics of runaway electrons and their interaction with tokamak liners. Liu, C.S.; Mok, Y.C.; Papadopoulos, k.; Engelmann, F.; Bornatici, M. (University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **39**: No. 11, 701-704(12 Sep 1977).

A nonlinear theory of the collective processes in runaway tokamak discharges is presented. The conditions under which runaway electrons can be trapped in toroidal field ripples, leading to liner damage, are derived and compared with the experimental evidence.

9357 Numerical simulation of proton rings during static compression and trapping. Marsh, S.J.; Drobot, A.T.; Golden, J.; Kapetanakos, C.A. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev. Lett.;* **39**: No. 11, 705-708(12 Sep 1977).

Results are reported from a numerical-simulations study on the propagation of a rotating proton pulse and the formation and trapping of the resulting strong proton ring. It is observed that the self-magnetic field has a very pronounced effect on the dynamics of such systems, and is responsible for a somersaulting and energy spread of the beam.

9358 Lower-hybrid heating of a plasma in tokamaks. Musher, S.L.; Rubenchik, A.M.; Sturman, B.I. (Institute of Automation and Telemetry). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 333-336(20 Apr 1977).

We consider plasma heating by an RF field at frequencies close to the lower hybrid frequency. Calculations are performed for heating by a fast and a slow wave. The spatial distribution of the absorbed power is obtained.

9359 Neutral injection plasma in the Culham levitron. Freeman, R.; Riviere, A.C.; Sweetman, D.R. pp C3, 1p. of In 3rd international symposium on toroidal plasma confinement. Garching, Germany; Max-Planck-Inst. of Plasmaphysics (1973).

From 3. international symposium on toroidal plasma confinement; Garching, Ger. (26 Mar 1973).

A beam of 5 keV neutral atoms was injected and trapped in a toroidal experiment. There appears to be no anomalous loss of these injected ions at least for times of order 4 msec. The resulting cold plasma produced by their ionization of the gas has a lifetime of several hundred milli-seconds which, provided no additional loss of plasma occurs, should be sufficient to allow exponentiation to higher densities where heating from the injected ions becomes significant.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 9469, 9470

9360 (EUR-CEA-FC—873) **Considerations on Tsub(i) measurement by the method of fast charge-exchange-neutrals in Petula.** Gregoire, M.; Weisse, J.; Bardet, R. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). Jan 1977. 36p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

Some considerations are given on the analysis of fast charge-exchange-neutrals after experimentation on the classical Tokamak, Petula (metallic liner). This diagnostic commonly used in plasmas where Tsub(i) reaches a few hundred eV, offers certain difficulties though it gives also some possibility scarcely used. The research has been effected in view of measuring the increase in the ion temperature induced by T.T.M.P. in the future experimental phase of Petula. A simple simulation code taking into account the ion vertical drift, and neutrals reabsorption is used to explain the results already obtained.

9361 (PPPL—1383) **Soft x-ray measurements on the PLT Tokamak.** Von Goeler, S.; Sauthoff, N.; Bitter, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1977. Contract EY-76-C-02-3073. 18p. Dep. NTIS, PC A02/MF A01.

Four experiments are described that currently run on the PLT tokamak and which utilize the soft x-ray emission of the plasma as a diagnostic: the pulse height analysis system for temperature and impurity measurements; the curved crystal Bragg spectrometer for the determination of ionization states of impurities; "windowless" surface barrier detectors for the investigation of the ultra soft x-ray radiation in the energy range 0.1 keV $< h\nu <$ 1 keV and a silicon diode array for x-ray fluctuation measurements. For each diagnostic a short technical description and some recent results obtained with it on PLT are given in order to demonstrate its use.

9362 (TRITA-EPP—76-16) **Electrical probe measurements in low and high pressure discharges.** Andersson, D. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Elektronfysik). Nov 1976. 7p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The construction of an apparatus for automatic determination of electron distributions is described, whereafter measurements of electron energy distributions before and after a stationary plasma sheath in a low pressure mercury discharge are presented. The sheath appears at a constriction of the discharge tube. The measurements have been made with a spheric probe, using the second-derivative method, and the results show that the energy distribution on the anode side of the sheath is a sum of a thermal population and an accelerated distribution. Near the sheath the accelerated electrons suffice to carry the discharge current, but far from it the current must be carried by an anisotropy in the thermal part of the distribution function. A comparison is made with calculated distributions. The cross-sections for electron-neutral and Coulomb collisions are not sufficient to account for the damping of the accelerated population, suggesting the presence of a plasma instability. In order to study the distribution function of the axial velocity component, preliminary measurements of the first derivative of the current to a plane probe have been made. Such measurements yield information about the anisotropy and the current transport, and may perhaps shed some light on the phenomenon of current limitation. Some measurements on a TIG welding arc are also described.

9363 (TRITA-EPP—76-21) **Velocity of particles released by plasma stream erosion of surfaces; spectroscopical Doppler measurements.** Kristoferson, L. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). Dec 1976. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Velocity measurements of particles released from solid target surfaces exposed to a 300 eV proton plasma stream show a variety of particles with widely differing velocities. A spectroscopic doppler technique is used where two spectra of the same region, but taken from opposite directions, are imaged together on the film. This technique eliminates most of the calibration difficulties with the normal method using reference spectra, and it also gives more accurate results. Particles originating from the target bulk material are observed to be released with low energies, a few eV corresponding to less than 10^3 ms^{-1}, as expected for physical and chemical sputtering. Some impurity particles (i.e. oxygen and carbon atoms), probably adsorbed to the surface, are however observed to be released with very high energies, sometimes several 100 eV corresponding to several times 10^4 ms^{-1} roughly equal to the plasma proton energies.

9364 **Determination of plasma Z-pinch effect by intrinsic stimulated emission.** Lue, J.T.; Liang, J.M. (Department of Physics, National Tsing Hua University, Hsinchu, Taiwan, Republic of China). *Appl. Phys. Lett.;* **31**: No. 12, 798-800(15 Dec 1977).

The plasma Z-pinch behavior has been observed in a relatively small-bore diameter tube and low bank voltage discharge system. The instant of the occurrence of the laser line at 4880 A coincides with the plasma pinch time calculated by using a one-fluid snowplow model. A determination of plasma pinch parameters by measuring the intrinsic stimulated emission of the ions is described.

9365 **Characterization of an ultradense reproducible Z pinch.** Duston, D.; Rockett, P.D.; Steel, D.G.; Ackenhusen, J.G.; Bach, D.R.; Duderstadt, J.J. (The University of Michigan, Ann Arbor, Michigan 48109). *Appl. Phys. Lett.;* **31**: No. 12, 801-803(15 Dec 1977).

The apparent complexity of the laser-plasma coupling in laser fusion target irradiation has stimulated the need for carefully controlled experimental studies of the laser-plasma interaction at the critical surface. A helium Z pinch has been constructed which produces a high density plasma, independent of the laser, enabling the separation of the laser-plasma interaction physics from the plasma formation mechanism. Its peak electron density (4×10^{19} cm^{-3}), critical density scale length (70—200 μ), and temperature (~25 eV) make it suitable for simulating and studying laser-pellet interaction mechanisms at CO_2 laser wavelengths. Detailed numerical modelling of these experiments was employed as a check against our diagnostics, as well as providing physical insight in those ranges of experimental parameters where measurements were not made.

9366 **Directional rf probe for measurement of conductivity of flowing plasmas.** Jayakumar, R.; Chakravarthy, D.P.; Rohatgi, V.K. (Plasma Physics Section, Bhabha Atomic Research Centre, Bombay, India). *Rev. Sci. Instrum.;* **48**: No. 12, 1706-1709(Dec 1977).

An electrodeless immersible rf probe for measurement of plasma conductivity in the range 0.01 to 100 mho/m has been designed and fabricated. The probe, with an overall diameter of 11 mm, employs unidirectional electromagnetic field lines which reduce the inaccuracies caused by insertion of the probe in a flowing plasma. In the range studied the probe output shows a linear relationship with the conductivity of the medium. Such probes are of interest in the study of MHD and reentry plasmas.

9367 **Millimeterwave spectroscopy of active laser plasmas; the excited vibrational states of HCN.** De Lucia, F.C.; Helminger, P.A. (Department of Physics, Duke University, Durham, North Carolina 27706). *J. Chem. Phys.;* **67**: No. 9, 4262-4267(1 Nov 1977).

Millimeter and submillimeter microwave techniques have been used for the spectroscopic study of an HCN laser plasma. Forty-seven rotational transitions in 12 excited vibrational states have been observed. Numerous rotational, vibrational, and perturbation parameters have been calculated from these data. A discussion of experimental techniques is included.

9368 **Technique for measuring the differential ion flux vector.** Stone, N.H. (Space Sciences Laboratory, Marshall Space Flight Center, Huntsville, Alabama 35812). *Rev. Sci. Instrum.;* **48**: No. 11, 1458-1463(Nov 1977).

A diagnostic technique is discussed which gives the angle of incidence of a plasma stream, the energy corresponding to the mean velocity of the ions, and the distribution of the ion thermal motion superimposed on the drift. The technique is shown to be operable for low-energy plasma streams (5—60 eV) and in the presence of multiple plasma streams differing in direction and/or energy. Resolution is better than 3.5° with ~1% energy spread in the streams. The instrument samples the plasma at a single region in space, independent of the number of plasma streams or their characteristics. The technique was developed to investigate plasma flow interactions in the laboratory. Its capabilities are demonstrated by some preliminary data taken for the case of a long cylindrical body inmersed in a drifting, collisionless plasma.

9369 **Spectroscopic measurements on a high-density Z-pinch plasma.** Mercier, J.; Neufeld, C.R. (INRS-Energie, Varennes, Quebec, Canada J0L 2P0). *J. Appl. Phys.;* **48**: No. 11, 4498-4502(Nov 1977).

Using results of the quasistatic line-broadening theory applied to the blue wing of the H/sub β/line produced in a hydrogen Z-pinch discharge, a measured average electron density of at least 1.2×10^{19} cm^{-3} during the first compression has been obtained. The fitting remains good for wavelength displacements from the unperturbed line center somewhat smaller than the critical displacement for electron impacts given by the quasistatic theory, but clearly fails near the line center, where collisions dominate the profile. The measured density is consistent with relative continuum intensity measurements obtained from similar devices by other authors. The pinch plasma represents a target of critical electron density for CO_2 laser radiation, and laser-plasma interaction experiments using this target are under way.

9370 **Time- and space-resolved spectroscopic studies of electrical breakdowns in an argon-hydrogen mixture.** Wiese, L.L.; Augis, J.A. (Bell Telephone Laboratories, Columbus, Ohio 43213). *J. Appl. Phys.;* **48**: No. 11, 4528-4535(Nov 1977).

Emission spectra from a 6-A 250-ns cable discharge between gold electrodes in a mixture of 90% Ar + 10% H_2 at atmospheric pressure have been obtained both with and without time resolution as a function of position in the gap. The Stark broadening of the hydrogen H/sub β/line and of Ar II lines has been used to estimate the electron density in the gap which is observed to exceed 10^{18} cm^{-3} during the first 100 ns of the discharge. A quasi-steady-state is observed after approximately 100 ns until current extinction, during which time the Ar II populations are given by Boltzmann statistics with a temperature of ~20 000 °K. The results of the time-integrated and time-resolved studies are compared to provide information about the effects of spatial and temporal integrations on measured parameters. The qualitative features of the spectra together with estimates of the plasma equilibration time indicate that it may be possible to use a local thermodynamic equilibrium (LTE) model of the plasma to quantiatively study the electrode erosion process.

9371 **Determination of electron density and electron collision frequency in a nonuniform plasma column by rf coil probe.** Basu, J.; Hore, K. (Saha Institute of Nuclear Physics, Calcutta, India). *J. Appl. Phys.;* **48**: No. 11, 4812-4814(Nov 1977).

A nonimmersive-coil-probe method is presented for determining the electron density and electron collision frequency for momentum transfer in a cylindrical plasma column with a Bessel-type density distribution along the radius, the plasma being either isotropic or embedded in an axial static magnetic field. The method is based on the relation between the plasma parameters and the impedance of an rf coil placed coaxially around the plasma. Simplified expressions relating the parameters to the coil impedance are found to be valid under suitable conditions in the isotropic case.

9372 **Stark broadening of singly ionized silicon.** Lesage, A.; Sahal-Brechot, S.; Miller, M.H. (Observatoire de Paris, Section d'Astrophysique de Meudon, 92190 Meudon, France). *Phys. Rev., A;* **16**: No. 4, 1617-1624(Oct 1977).

Linewidths and shifts of the five prominent visible Si II multiplets are measured in a conventional shock tube. The Stark effect from impacting plasma electrons is the dominant broadening

mechanism. Electron densities range widely [(4—15) x 10^{16} cm^{-3}], but temperatures (9500—12 500 °K) do not. Optical depth and source inhomogeneity are rarely troublesome. Depending upon interference, blending, and signal-to-noise ratios, broadening-parameter accuracies are between 15—25% and shift uncertainties are 15—100%. Comparison data are examined.

9373 Line broadening and self-absorption of Be IV in a laser-produced plasma. Tondello, G.; Jannitti, E.; Malvezzi, A.M. (Centro Gas Ionizzati, Consiglio Nazionale delle Ricerche, Universita di Padova, Padova, Italy). *Phys. Rev., A;* **16**: No. 4, 1705-1714(Oct 1977).

The time-integrated spectrum from a plasma of beryllium produced by a 1-GW ruby laser has been observed in the soft-x-ray region with spectral and spatial resolution. The lines of Be IV are broadened near the target. Stark broadening and a Doppler shift due to the expansion of the plasma towards the vacuum combine with the opacity of the plasma itself to give an apparent profile with asymmetrical shift reversal. The equation of radiative transfer is solved in this case with a computed plasma model. Parameters like electron temperature, and density and plasma dimensions have been spectroscopically measured, while Stark parameters have been adopted from the theory. The profiles predicted by the model are in good agreement with the observed ones, especially if time-dependent ionization equilibria are considered. Electron densities inferred from Stark-broadened lines can be estimated up to densities of 10^{21} cm^{-3}.

9374 Observation of Ti XXI-Fe XXV spectra in x-ray emission of a laser plasma. Mikhailov, Y.A.; Pikuz, S.A.; Sklizkov, G.V.; Faenov, A.Y.; Fedotov, S.I. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 5, 469-471(May 1977).

Using fast x-ray spectrographs, we obtained the spectra of the He-like ions Ti XXI...Fe XXV formed in a laser plasma for a heating radiation flux density 10^{14} W/cm^2. A characteristic feature of the spectra is the presence of intense satellite lines corresponding to transitions from doubly excited levels of Li, Be, etc., ions. The measured electron temperature was approximately 800 eV, and the ionization temperature approximately 500 eV, which confirms the fact that the laser plasma under the expeimental conditions was ionizing. The spectrum of Fe XXV obtained in the present experiment is compared with spectra obtained previously in the solar corona and the vacuum spark.

9375 Time dependence of x-ray spectrum of an aluminum laser plasma. Kas'yanov, Y.S.; Mazing, M.A.; Chevokin, V.K.; Shevel'ko, A.P. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 348-351(20 Apr 1977).

The time dependence of the spectral lines of hydrogenlike and heliumlike alumium ions in the x-ray emission spectrum of a laser plasma is investigated. The ratio of the line intensities in the spectrum is used to determine the temperature and density of the electrons with a time resolution not worse than 1.8 nsec.

9376 Measurement of the electron temperature and density distributions in the plasma in the TM-3 Tokamak installation by the method of laser radiation scattering. Sannikov, V.V. *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 63-67(Jan 1977).

Electron temperatures of 0.15—1.2 keV have been measured at plasma densities n-bar/sub e/=6 x 10^{12}—6 x 10^{13} cm^{-3} under stable discharge conditions in the TM-3 Tokamak installation by the method of Thomson scattering. The electron temperature and density distributions along the plasma column radius have been obtained for different plasma parameters. The variation in time of the plasma-electron density and temperature profiles has been measured in one of the standard regimes (H/sub z/=22kOe, J=50 kA, n-bar/sub e/ =6 x 10^{13} cm^{-3}). The diamagnetic and laser measurements have been compared.

9377 Probe for the measurement of magnetic fields with subnanosecond resolution. Serov, R.; Richardson, M.C.; Burtyn, P. (Natl Bur Counc of Can, Ottawa, Ont). *Rev. Sci. Instrum.;* **46**: No. 7, 886-888(Jul 1975).

A double coil differential magnetic probe has been specifically devised for the measurement of magnetic fields with high temporal and spatial resolution. Having a response time of >1 nsec, a sensitivity of 0.3 V nsec G(sup -1), and high discrimination (>300) to all other types of background interference, it is well suited to the analysis of magnetic fields associated with plasmas produced by ultrashort laser pulses. 9 refs.

9378 Probeless diagnostic techniques in gas dynamics and plasma physics. I. Density measurements. Klimkin, V.F.; Shipulin, E.M.; Iasakov, V.A. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). *Arch. Termodyn. Spalania;* **6**: No. 2, 237-275(1975). (In Russian).

Optical methods for measuring density in a gas or plasma stream, with emphasis on measurements in detonation plasmas, are reviewed. Applications of several optical diagnostic techniques are reviewed in detail. These include: (1) shadowgraph and schlieren techniques; (2) interferometric techniques, and in particular holography, based on recording the phase shift introduced by the test medium; (3) techniques studying the intensity of emission attenuated by absorption or scattering in the medium. The advantages of lasers as light sources in this work are discussed.

PLASMA KINETICS - GENERAL

9379 (TRITA-EPP—76-23) **Fusion research at the Royal Institute of Technology in Stockholm 1977.** Lehnert, B. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Dec 1976. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Reviews are given on the research activities in plasma physics and controlled fusion during 1976 as well as on the plans for research in 1977, including short descriptions and motivations of the lines of approach being conducted by the laboratory. These lines include plasma-neutral gas interaction and stability, also with special approaches to plasma stabilization, magnetic confinement being mainly produced by poloidal fields, as well as heating and diagnostics of impermeable plasmas.

PLASMA KINETICS - EXPERIMENTAL

9380 (N—77-21969) **Vortex flow in a torus. A method for arc stabilization.** Polman, R.W. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Aug 1976. 115p. (REPT—76-97). NTIS PC A06/MF A01.

Experiments on ring vortices inside a torus and experiments on semi-toroidal arcs stabilized by such vortices are described. The studies were performed in two separate devices. One of the toroidal vortex chambers, Cogion, with R = 0.45 m and r = 0.10 m permits the establishment of a gas flow only. In the other device, Tovorex, with R = 0.19 m and r = 0.04 m, it is also possible to draw a semi-toroidal arc. In both devices, the toroidally symmetric ring vortices are obtained by poloidal injection and exhaust of gas through slits running in toroidal direction and extending over the whole circumference. The arcs are drawn between two tungsten electrodes in the core of the rotating flow. The arc can be given an adjustable length of 1.0 m maximum, which only covers a part of the 1.2 m long circular vortex axis; therefore the term semi-toroidal arc is used. The rotation of the gas forces the discharge into the core of the vortex, thus preventing it from coming into contact with the metal wall.

9381 Equation of state of cesium plasma at p=30-140 atm and T=3000-4000°K, obtained by the method of adiabatic compression. Bravyi, B.G.; Vetchinin, S.P.; Kirillin, A.V.; Kunavin, A.T. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 1-6(Jul 1977).

Using experimental p—v—s data obtained in an adiabatic compression apparatus, the thermodynamically complete equation of state of cesium plasma is constructed. A comparison is drawn between the results obtained in this way, certain model calculations, and the data of other authors. In the range of parameters indicated, the thermodynamic properties of cesium plasma may be described perfectly satisfactorily by the ideal plasma model.

9382 Observation of a persistent, energetic-electron current in the superconducting levitron. Anderson, O.A.; Birdsall, D.H.; Hartman, C.W.; Hooper, E.B. Jr. (Univ. of California, Livermore). *Phys. Rev. Lett.;* **32**: No. 6, 274-277(11 Feb 1974).

An induced current of up to 8 ka, flowing for several seconds, has been observed in a hot-electron plasma confined in the superconducting levitron device. Energetic electrons are the current carriers and the current decays by classical collisions.

PLASMA KINETICS - THEORETICAL

9383 (JEN—368) **One-dimensional model simulating the energy distribution of neutrals going out of a tokamak plasma.** Barrado, J.M.; Blazquez, J.B.; Perez-Navarro, A.; Zurro, B. (Junta de Energia Nuclear, Madrid (Spain)). 1977. 43p. (In Spanish). Dep. NTIS (US Sales Only), PC A03/MF A01.

An one-dimensional model to analyze the neutral atoms penetration into a hot plasma has been introduced in order to get the ionic temperature from the energy distribution of the charge exchange neutrals, which is obtained following a Monte Carlo procedure. The model enhances the influence of the non homogeneous charge-exchange and temperature profiles over the energy distribution. It also shows haw the inner neutrals are screened by the plasma external layers and the dependence of the effective temperature on the charge-exchange cross section. Results agree with experimental data and with obtained through some others more elaborated models.

9384 (LBL—6824) **Stochastic acceleration by a single wave in a magnetized plasma.** Smith, R. (California Univ., Berkeley (USA). Dept. of Physics). 22 Sep 1977. Contract W-7405-ENG-48. 242p. Dep. NTIS, PC A11/MF A01.

Thesis.

A particularly simple problem exhibiting stochasticity is the motion of a charged particle in a uniform magnetic field and a single wave. Detailed studies of this wave-particle interaction show the following features. An electrostatic wave propagating obliquely to the magnetic field causes stochastic motion if the wave amplitude exceeds a certain threshold. The overlap of cyclotron resonances then destroys a constant of the motion, allowing strong particle acceleration. A wave of large enough amplitude would thus suffer severe damping and lead to rapid heating of a particle distribution. The stochastic motion resembles a diffusion process even though the wave spectrum contains only a single wave. The motion of ions in a nonuniform magnetic field and a single electrostatic wave is treated in our study of a possible saturation mechanism of the dissipative trapped-ion instability in a tokamak. A theory involving the overlap of bounce resonances predicts the main features found in the numerical integration of the equations of motion. Ions in a layer near the trapped-circulating boundary move stochastically. This motion leads to nonlinear stabilization mechanisms which are described qualitatively.

9385 (PPPL—1386) **Electron heat transport in a tokamak with destroyed magnetic surfaces.** Rechester, A.B.; Rosenbluth, M.N. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1977. Contract EY-76-C-02-3073. 12p. Dep. NTIS, PC A02/MF A01.

Formulas for the electron thermal conductivity have been derived in the collisional and collisionless limits for the case of destroyed magnetic surfaces.

9386 (UCID—17050) **880 nanosecond particle in cell mover for the CDC 7600.** Estabrook, K.; Tull, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Oct 1977. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

A very fast computational method of moving particles for one dimensional electrostatic plasma simulations using integer arithmetic is described. The cloud in cell method forms the basis of this technique. This paper is in the form of a compass compilable subroutine with comments and examples describing methods of using an entirely integer representation to gain up to an order of magnitude increase in speed over equivalent floating point Fortran coding. Integer arithmetic has several advantages over floating point arithmetic for one dimensional particle movers. The adds are much faster, and the binary numerical description allows the implementation of very simple boundary conditions if the simulation region extends from zero to a power of two. Furthermore, integer arithmetic makes very efficient use of each memory bit since there is no floating point exponent. Consequently, it becomes feasible and fast in long word length machines to pack the velocity and position of a particular particle into the same word, thus saving a factor of two in computer storage and/or 10. These advantages are combined with the fact that integer adds and logicals complete in only two computer cycles allowing nearly complete optimization of register and instruction interleaving. The measured timings on a CDC 7600 are 880 nanoseconds and 935 nanoseconds per particle for the periodic and general boundary condition sections respectively. Methods for adapting the technique to other computers are discussed.

9387 (USIP—76-28) **Plasma turbulence. II. Operator formulation.** Svaton, E.M. (Stockholm Univ. (Sweden). Fysiska Institutionen). Dec 1976. 29p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Presents the major theories of plasma turbulence and points out the differences and similarities in the mathematical formulations. The theories of Rudakov-Tsytovich and Weinstock-Dupree seems to be to some extent identical, at least in this operator formulation, except for the methods of solution of the final equations. The theory of Balescu-Misguich contains additional terms by explicit introduction of memory effects. Their effect upon diffusion coefficients for various spectra (and thus on the evolution of the distribution function) is being investigated and will be published elsewhere. Although formally they are capable of handling strong turbulence, mathematical difficulties limit their applicability to weak turbulent fields. Also the time scale of their validity is not always clear and one can think of weak fields acting for a long time giving rise to density fluctuations and trapping of the waves, an effect which belongs more properly to strong turbulence. Strong turbulence, at this time, is, however, only a partially explored subject.

9388 **Pfirsch—Schlueter friction in present tokamak plasmas.** Hazeltine, R.D.; Ware, A.A. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 11, 1880-1886(Nov 1977).

The collisional friction force between two plasma species determines several quantities, such as particle diffusion rates, of central importance in tokamak transport theory. For an impure plasma in a regime of mixed collisionality, as pertains to most present tokamak experiments, electrostatic trapping leads to an unusually strong friction force, associated with slowly moving particles, which cannot be evaluated using the standard techniques of neoclassical kinetic theory. The Pfirsch—Schlueter part of the friction force is computed, and shown to depend logarithmically on parameters characterizing the tokamak equilibrium.

9389 **Multiple-bounce and snowplow model expansions of exploding plasmas.** Albritton, J.R. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). *Phys. Fluids;* **20**: No. 11, 1915-1919(Nov 1977).

Multiple-bounce and snowplow models are employed to analyze the expansion dynamics of the interface separating exploding sheet and line mass plasmas from constant external pressure fields. The snowplow model is shown to be a successively poorer approximation to the multiple bounce when comparing systems of increasing total interface curvature; specifically, planar, cylindrical, and spherical systems are investigated.

9390 **New three-dimensional simulation models for cylindrical and toroidal plasmas.** Cheng, C.Z.; Okuda, H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *J. Comput. Phys.;* **25**: No. 2, 133-150(Oct 1977).

A new class of three-dimensional particle simulation models using finite-size particles has been developed which is useful for studying plasma behavior in large, cylindrical, and toroidal systems. The model makes use of the combination of eigenfunction expansion in one direction and the multipole expansion on a two-dimensional spatial grid for solving the Maxwell equations and for pushing particles. For a toroidal system, the Poisson equation is solved by using the cubic spline technique in the radial direction. It is shown that, using presently available computers, full three-dimensional simulations may be carried out for real plasma devices such as tokamaks or pinch devices where only several eigenmodes are required in the axial direction. Results of the simulations for the thermal fluctuations are shown to agree with the theoretical predictions for both cylindrical and toroidal systems.

9391 **Theory of the optical properties of a nonideal plasma.** Kobzev, G.A.; Kurilenkov, Y.K.; Norman, G.E. (High-Temperature Institute, Academy of Sciences of the USSR). *High Temp. (USSR) (Engl. Transl.);* **15**: No. 1, 163-166(Jul 1977).

The photorecombination and photoionization absorption spectra are calculated as a function of plasma density. The results are compared to experimental data on Xe and Ar. (AIP)

9392 **Compton effect and pair production for relativistic particles in a plasma.** Kleiman, E.B.; Tsytovich, V.N. (Gor'kii State University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 80-83(Jan 1977).

We evaluate the probabilities for the Compton effect and electron-positron pair production by two transverse quanta in an isotropic plasma. We obtain in the ultra-quantal limit an expression for the Compton energy loss of an electron in the case when the frequency of the initial quantum is close to the plasma frequency. We show that the plasma alters significantly the nature of the emission. We find the spectral power of the radiation by a system of ultrarelativistic electrons. We obtain an expression for the γ-quantum energy loss due to pair production.

9393 **Drift-kinetic equation for a tenuous plasma in the presence of high-frequency fields.** Milant'ev, V.P. (Patrice Lumumba University). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 84-89(Jan 1977).

An averaging method is used to obtain an approximate kinetic equation for a collisionless plasma in the drift approximation in the presence of a high-frequency field in the form of a quasimonochromatic wave, both in the absence of resonance conditions and under cyclotron-resonance conditions.

9394 **Plasma physics.** Laing, E.W. New York; Crane, Russak and Co., Inc. (1976). 169p. .

The book is essentially in two parts, with the first four chapters laying the foundations of the subject. In Chapter 1, elementary concepts are introduced which will reappear in various guises throughout. This is followed by three chapters which emphasize different facets of plasma behavior. Chapter 2 outlines the subtleties of the motion of a charged particle in given inhomogeneous electric and magnetic fields. The fluid behavior of a plasma in its interaction with magnetic fields is discussed in Chapter 3, while Chapter 4, on plasma kinetic theory, introduces the reader to collective phenomena, in which the particle and fluid behavior are intimately related. Chapter 5 gives a brief account of magnetic confinement of plasma in laboratory experiments; Chapter 6 touches on several topics in astrophysics; Chapter 7 outlines the basic ideas involved in laser compression of plasma to ultra-high densities; the book ends with a survey of computational plasma physics.

9395 **Consideration of non-Coulomb corrections of plasma kinetic coefficients.** Podlubnii, L.I. (Inst. of Energy, Moscow). *Teplofiz. Vys. Temp.;* **13**: 1081-1084(1975). (In Russian).

It is generally throught that disparities in the equilibrium and transport properties of plasmas is due only to the presence of neutral particles, and that these disparities disappear in the case of a fully

ionized plasma. In this paper it is argued that disparities in these properties persist even in a fully ionized plasma due to scattering on the electron shells of ions, which is present along with purely Coulomb scattering. To demonstrate this argument, the quantum defect method is used to calculate transport cross sections, taking into account finite dimensions of ions, in a real, cold plasma.

9396 K teorii diskretnykh modelei plazmy. (Theory of discrete models of plasmas). Sigov, I.S. (Inst. of Applied Mathematics, Moscow); Khodyrev, I.V. Moscow; Institut Prikladnoi Matematiki (1975). 31p. (In Russian).

A classification of basic discrete models of rarefied plasma is presented, based on a distribution function in the form of linear integral transformations with degenerate and symmetrical kernels applied to the point particle distribution function. This representation is used to obtain an equation for the motion of macroparticles taking into account the local conservation laws in the discrete system. A dispersion relation is obtained for systems of interacting particles of finite size, which is averaged on the basis of initial system states.

PLASMA PRODUCTION

9397 (CEA-R—4806) **Argon plasma created by intense shock waves.** Udiment, B. (CEA Centre d'Etudes de Vaujours, 93 - Sevran (France); Rouen Univ., 76 - Mont-Saint-Aignan (France)). Mar 1977. 72p. (In French). Dep. NTIS (US Sales Only), PC A04/MF A01. Thesis.

The shock tube of the Vaujours Research Centre can supply high-speed shock waves. The plasmas created by such waves spreading in argon at an initial pressure of 660 Pa (5 mm Hg) were studied. To obtain a homogeneous plasma it is necessary to limit the shock wave speed to 6000 m/s. In the speed range studied (4500 to 5300 m/s) the electron density was determined using conventional interferometric methods in monochromatic light and the population of an excited argon level and the continuous radiation intensity using spectrophotometry.

9398 Calorimeters for measurement of ions, x rays, and scattered radiation in laser-fusion experiments. Gunn, S.R.; Rupert, V.C. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Rev. Sci. Instrum.;* **48**: No. 11, 1375-1380(Nov 1977).

Several types of calorimeters have been developed for measuring ions, x rays, and scattered radiation produced by fusion experiment targets imploded by laser pulses. One version for ions and x rays uses metal absorbers in a differential arrangement to compensate for the small fraction of scattered laser radiation that is also absorbed; the other version uses a glass absorber which transmits most of the scattered laser radiation. The scattered-radiation calorimeters use a transparent glass shield to remove ions and x rays and colored glass to absorb the radiation.

9399 Ion composition in the plasma produced by a CO_2 laser. Berezovskii, V.V.; Bykovskii, Y.A.; Sil'nov, S.M.; Suslov, A.I.; Sharkov, B.Y.; Shuvalov, S.M. *Sov. Tech. Phys. Lett. (Engl. Transl.);* **3**: No. 4, 126-127(Apr 1977).

Aluminum and carbon targets were irradiated with CO_2 laser radiation. The production of ions in the resultant plasma was studied as a function of the radiation intensity.(AIP)

9400 Numerical method of calculation of electric arc parameters. Prokof'ev, A.N. *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 3, 81-85(1977). (In Russian).

A method and results of calculation of the parameters of an electric arc, burning in the laminar flow of argon along the sector of gas entry into the duct of an electric arc heater, are presented. An analysis of the results obtained confirms that the mathematical model of the discharge has been correctly chosen.

9401 Comment on the production of fast ions by laser light pressure. Mulser, P.; Van Kessel, C. (Max-Planck-Gesellschaft, Garching bei Muenchen). *Phys. Lett., A;* **59**: No. 1, 33-34(1 Nov 1976).

Since the laser light pressure can be written as a gradient of a potential, long pulses, i.e., of ns duration, cannot effectively accelerate a noticeable portion of ions to superthermal velocities.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 9431, 9438

9402 (KIYI—74-34) **Thermonuclear cyclotron-magnetoacoustic plasma instability.** Belikov, V.S.; Kolesnichenko, Ya.I. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). 1974. 19p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The presence of small quantity of thermonuclear reaction production in plasma is shown to be sufficient for cyclotron-magneto-acoustic waves excitation. The criteria of the existence of instability are obtained. The instability development conditions in the toroidal system and in the adiabatic trap are compared. The effectiveness of the instability stabilization by the shear is studied. It is shown that even in presence of the significant shear in the system the instability can be reserved; however, the threshold values of reaction products concentration growing.

9403 (KIYI—75-12) **Study of the effect of plasma parameter inhomogeneities on the decay instability excitation.** Pasechnik, L.L.; Semenyuk, V.F. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). 1975. 10p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The influence of the space inhomogeneity of the plasma density and the steady-state electric field on the parametric decay instability has been experimentally investigated. The increase of the threshold instability and the reductions of the steady-state amplitude of the decay oscillations have been found when the dimension of the plasma density inhomogeneity along the magnetic field can be compared with the pump wave length and the length of the homogeneous part of the plasma column. The similar phenomenon has been observed in the presence of the radial inhomogeneity of the longitudinal steady-state electric field with the strength, near to the amplitude of the pump field. The steady-state amplitude reduction of the decay oscillations under the origin of the LF plasma density fluctuations with the frequency of the order of the decay instability growth rate have been observed also.

9404 (N—77-24950) **An explanation of the apparent contradiction between the Suydam and closed-line stability criteria.** Hellsten, T. (SEE ALSO- 6140560 Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Jan 1977. 31p. (TRITA-EPP—77-05). NTIS PC A03/MF A01.

The discrepancy between the Suydam criterion in the limit of low shear and the closed-line criteria is discussed. The unstable spectrum was investigated for a straight hard-core pinch surrounded by conducting walls. As the shear decreases, the unstable spectrum moves to higher axial wave numbers. It is likely that these modes can be stabilized by finite Larmor radius effects in the limit of low shear. Stable equilibria should then exist with a descreasing pressure in absence of an axial magnetic field.

9405 (NRL-MR—3506) **Rayleigh—Taylor instability in a layered laser-driven target.** Felber, F.S. (Naval Research Lab., Washington, D.C. (USA)). Sep 1977. Contract ES-77-A-01-6021. 21p. Dep. NTIS, PC A02/MF A01.

Growth rates of Rayleigh-Taylor modes, particularly those of long wavelength, are reduced at fluid interfaces in inhomogeneous laser-driven targets by the density gradients occurring naturally as a result of the acceleration. Growth rates can be reduced further by interposing layers of intermediate density at unstable interfaces between layers of high and low density, and by fabricating target layers with favorable density gradients between discontinuities. An approximate closed form expression for the growth rate of fluid instabilities in a multi-layered laser-driven target is presented.

9406 (TRITA-EPP—76-17) **Plasma neutral gas interaction effects on the stability of drift modes.** Ohlsson, D. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Nov 1976. 37p. Dep. NTIS (US Sales Only), PC A03/MF A01.

In quasi-steady fusion reactors partially ionized boundary layers are likely to be formed. The plasma density is then expected to be peaked close to the boundary. The possibility of large density gradients driving unstable drift modes in these layers is investigated. The expected magnetic shear, due to induced plasma currents in such systems, as well as minimum-average-B properties of the magnetic field, are probably insufficient to significantly influence the stability properties of these modes. However, effects associated with plasma-neutral gas interactions as well as with a finite Larmor radius and ion viscosity modify the behaviour of drift modes and introduce stabilizing effects.

9407 (TRITA-EPP—76-18) **Magnetohydrodynamic stability of a plasma confined in a convex poloidal magnetic field.** Hellsten, T. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Nov 1976. 31p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A plasma confined in a purely poloidal magnetic field with a finite pressure at the boundary and surrounded by a conducting wall can be stabilized against magnetohydrodynamic perturbations even in absence of shear and minimum-average-B properties. To achieve large pressure gradients the average magnetic field has to decrease rapidly outwards. The theory is applied to a 'Spherator' configuration with a purely poloidal magnetic field.

9408 (TRITA-EPP—77-05) **Explanation of the apparent contradiction between the Suydam and closed-line stability criteria.** Hellsten, T. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen

foer Plasmafysik med Fusionsforskning). Jan 1977. 31p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The discrepancy between the Suydam criterion in the limit of low shear and the closed-line criteria is discussed. The unstable spectrum is investigated for a straight hard-core pinch surrounded by conducting walls. As the shear decreases, the unstable spectrum moves to higher axial wave numbers. It is likely that these modes can be stabilized by finite Larmor radius effects in the limit of low shear. It should then exist stable equilibria with a decreasing pressure in absence of an axial magnetic field.

9409 Influence of diffusion on the resistive tearing mode. Dobrott, D.; Prager, S.C.; Taylor, J.B. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **20**: No. 11, 1850-1854(Nov 1977).

Although resistive diffusion is much slower than the growth of resistive instabilities, the conventional neglect of diffusion in tearing mode calculations is incorrect. The proper criterion for neglect of diffusion in resistive instability calculations, which is not satisfied for tearing modes, is $\omega >> v/\delta$, where v is the resistive diffusion velocity and δ is the resistive layer thickness. The effect of diffusion is calculated in the limit of large and small $\omega\delta/v$ for the plane slab model, and new expressions for growth rate and stability boundary are obtained. The diffusion appears to have a stabilizing effect.

9410 Nonlinear saturation of two unstable modes; survival competition. Simon, A.; Migliuolo, S. (Department of Physics and Department of Mechanical and Aerospace Sciences, University of Rochester, Rochester, New York 14627). *Phys. Fluids;* **20**: No. 11, 1855-1863(Nov 1977).

A bounded uniform one-dimensional collisionless plasma is considered. The velocity distribution is of the "bump-on-tail" type and two linear eigenmodes with closely spaced wave vectors have phase velocities located on the lowest part of the positive slope of the bump. All other eigenmodes are assumed reasonably separated in phase velocity and located on negative (stable) slope regions. The time-asymptotic saturated nonlinear solutions are evaluated by a recently developed variation of the Bogoliubov method. In the "quasi-linear" approximation (i.e., zero-frequency mode coupling terms, alone, are retained) the only stable solution is one in which the initially fastest growing mode attains its "single-mode" amplitude and the second mode has zero amplitude. In the full nonlinear calculation, the result is the same unless the two modes are above a critical distance from the bottom of the slope. Above this critical value, there are two stable solutions. One as just described. The other in which the lower mode reaches its full single-mode amplitude and the first has zero amplitude. No stable solution exists for which both modes have finite amplitude. Similar mode survival competition may obtain in multi-mode situations.

9411 Lower hybrid parametric instabilities: Nonuniform pump waves and tokamak applications. Berger, R.L.; Chen, L.; Kaw, P.K.; Perkins, F.W. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 11, 1864-1875(Nov 1977).

Electrostatic lower hybrid "pump" waves are often launched into tokamak plasmas by structures (e.g., waveguides) whose dimensions are considerably smaller than characteristic plasma sizes. Such waves propagate in well-defined resonance cones and give rise to parametric instabilities driven by electron E x B velocities. The finite size of the resonance cone region determines the threshold for both convective quasi-mode decay instabilities and absolute instabilities. The excitation of absolute instabilities depends on whether a traveling or standing wave pump model is used; traveling wave pumps require the daughter waves to have a definite frequency shift. Altogether, parametric instabilities driven by E x B velocities occur for threshold fields significantly below the threshold for filamentation instabilities driven by pondermotive forces. Applications to tokamak heating show that nonlinear effects set in when a certain power-per-wave-launching port is exceeded. For sufficiently high powers, these instabilities will occur in the low-density edge region of a tokamak. They are characterized by a daughter wave frequency 10% below the pump wave frequency, in agreement with experimental observations.

9412 Influence of strong inhomogeneities and magnetic shear on microstability properties of the Tormac sheath. Gladd, N.T.; Goren, Y.; Liu, C.S.; Davidson, R.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **20**: No. 11, 1876-1879(Nov 1977).

Microstability properties of the Tormac sheath are discussed with particular emphasis on the influence of strong inhomogeneities and magnetic shear on the lower-hybrid-drift and mirror-drift-cone instabilities. It is found that magnetic shear can completely stabilize the lower-hybrid-drift instability (Maxwellian ions), and lead to a reduction in growth rate of the mirror-drift-cone instability (loss-cone ions). The persistence of the mirror-drift-cone instability (at a reduced growth rate) in the presence of moderate magnetic shear suggests that the addition of a cold plasma component (as in the 2X-IIB mirror experiment) may be desirable to further reduce the instability growth rate and suppress the associated anomalous transport.

9413 Influence of strong self-electric fields on the ion resonance instability in a nonneutral plasma column. Davidson, R.C.; Uhm, H. (Division of Magnetic Fusion Energy, Energy Research and Development Administration, Washington, D. C. 20545). *Phys. Fluids;* **20**: No. 11, 1938-1946(Nov 1977).

The influence of strong self-electric fields on the ion resonance instability is examined for a cylindrical nonneutral plasma column immersed in a uniform axial magnetic field B_0e_z. The analysis is carried out within the framework of a macroscopic cold-fluid model, and electrostatic stability properties are investigated for the case of rectangular electron and ion density profiles. The parameter $\delta = (2\omega_p^2/\omega^2 c)(1-f)$ is introduced as a convenient measure of the relative strengths of the equilibrium self-electric force and the magnetic force on an electron fluid element. (Here, ω_p is the electron plasma frequency, $\omega_c = eB_0/m_ic$ is the electron cyclotron frequency, $f = n_0/n_i$ is the fractional charge neutralization, and $\delta = 1$ corresponds to the maximum allowed charge density for radial confinement of the equilibrium configuration.) An important conclusion of this study is that the equilibrium self-electric field can have a large influence on stability behavior. In particular, stability properties for $\delta \ll 1$ or $\delta \gtrsim 1$ differ substantially from those obtained when δvery-much-less-than1. Moreover, for nonneutral plasma column with significant charge neutralization, it is found that the fundamental mode ($l = 1$) is not the most unstable mode. Rather, higher harmonic perturbations have larger growth rates. However, in the limiting case where fvery-much-less-than1 and δvery-much-less-than1, the $l = 1$ mode can have the largest growth rate, which is consistent with the result previously obtained by Levy, Daugherty, and Buneman.

9414 Energy distribution of a relativistic electron beam interacting with plasma. Jurgens, B.; de Haan, P.H.; Hopman, H.J.; de Jagher, P.C. (FOM-Institut voor Atoom-en Molecuulfysica, Amsterdam/Watergraafsmeer, The Netherlands). *Phys. Rev. Lett.;* **39**: No. 15, 936-939(10 Oct 1977).

The energy distribution of a relativistic electron beam which has interacted with a plasma was investigated. The beam parameters were 550 keV, 500 A, and 20 ns (full width at half-maximum). From the broadening of the energy spectrum by interaction with the plasma we calculated the axial-wave electric field of the electrostatic beam-plasma instability to be $E \approx 1.8 \times 10^6$ V/m. This is in reasonable agreement with values predicted from theory.

9415 Topology of ballooning modes. Coppi, B. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **39**: No. 15, 939-942(10 Oct 1977).

I identified the topology and main physical characteristics of plasma modes that can be driven unstable by the periodically unfavorable magnetic-field curvature, along a given field line in a magnetic confinement configuration. The relevant analysis has been carried out in order to explain the results of numerical fluid codes recently developed and to connect them with those obtained by a nonfluid (kinetic) analysis of microinstabilities in regimes of thermonuclear interest.

9416 Theory of ballooning modes in tokamaks with finite shear. Dobrott, D.; Nelson, D.B.; Greene, J.M.; Glasser, A.H.; Chance, M.S.; Frieman, E.A. (General Atomic Company, San Diego, California 92138). *Phys. Rev. Lett.;* **39**: No. 15, 943-946(10 Oct 1977).

We studied ballooning instabilities in tokamaks of arbitrary cross sections and finite shear. These azimuthally localized, ideal magnetohydrodynamic modes have large toroidal-mode numbers, but finite variation along the field and across the flux surfaces. Stability is determined by solving a second-order ordinary differential equation on each flux surface, subject to the proper boundary conditions. Qualitative agreement is achieved with the Princeton PEST stability code.

9417 Initial noise and quiet start (Q.S.) in electromagnetic particle simulation codes. Sternlieb, A. (Association EURATOM—CEA, Departement de Physique du Plasma et de la Fusion Controlee, Service IGn, Centre d'Etudes Nucleaires, 85 X, 38041 Grenoble Cedex, France). *J. Comput. Phys.;* **25**: No. 2, 118-132(Oct 1977).

We present the results of applying first and second moment quiet start, as suggested by Gitomer (Phys. Fluids 14 (1971), 1591), to simulation of electromagnetic ion-cyclotron instability. It is found that proper use of the above-mentioned method is necessary when accurate evaluations of growth rates with relatively few numbers of simulation particles are desired. An initial noise reduction of more than two orders of magnitude is obtained. This is equivalent to a large increase in the number of particles used, thus resulting in a substantial computer time saving. While carefully paying attention to such side effects as the "multibeam" formation, the Q.S. method, with its easy general applicability to 1-d, 2-d, and 3-d velocity space

dimensions, may be recommended as a reliable and powerful tool for routine usage in particle computer simulation of electromagnetic instabilities.

9418 Anomalous slowing of a perpendicularly injected ion beam in both quasilinear and trapping regimes. Yamada, M.; Seiler, S.W. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **39**: No. 13, 808-811(26 Sep 1977).

The anomalous slowing of an ion beam injected perpendicularly to the confining magnetic field of a low-β plasma is experimentally verified in the nonlinear stages of the excited lower-hybrid instability. Furthermore, a transition of the main nonlinear mechanism from the quasilinear to the particle-trapping regime is demonstrated by varying beam parameters.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 9411

9419 (TRITA-EPP—76-20) **Forced radial oscillations of a fully ionized cylindrical plasma surrounded by a partially ionized plasma shell.** Bures, M.; Tennfors, E. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Dec 1976. 32p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Forced radial magnetoacoustic oscillations of a fully ionized cylindrical plasma, surrounded by a partially ionized plasma shell are excited by means of an external source. The radial profiles of the macroscopic field quantities in the fully and partially ionized regions are obtained as functions of the degrees of ionization, the temperature and the position of the boundary between the two regions. The absorbed power is calculated. The nonresonant aa well as the resonant cases are treated. It is shown that the main part of the power is absorbed in the outer shell unless a suitable resonance is used to enhance the macroscopic field quantities in the fully ionized plasma part and the dimensions of the outer shell are kept small.

9420 Collisional damping of Langmuir waves in the collisionless limit. Auerbach, S.P. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 11, 1836-1844(Nov 1977).

Linear Langmuir wave damping by collisions is studied in the limit of collision frequency ν approaching zero. In this limit, collisions are negligible, except in a region in velocity space, the boundary layer, centered about the phase velocity. If κ, the ratio of the collisional equilibration time in the boundary layer to the Landau damping time, is small, the boundary layer width scales as ν/sup 1/3/, and the perturbed distribution function scales as ν/sup -1/3/. The damping rate is thus independent of ν, although essentially all the damping occurs in the collision-dominated boundary layer. Solution of the Fokker—Planck equation shows that the damping rate is precisely the Landau (collisionless) rate. The damping rate is independent of κ, although the boundary layer thickness is not.

9421 Stimulated scattering in a plasma filling an optical cavity. Meyer, J.; Myra, J.R. (Department of Physics, University of British Columbia, Vancouver, British Columbia, Canada). *Phys. Fluids;* **20**: No. 11, 1887-1891(Nov 1977).

Stimulated scattering processes in a homogeneous plasma inside an optical cavity are studied theoretically. In particular, attention is focused on the Raman and Brillouin instabilities. The coupled equations for the wave amplitudes are solved subject to optical cavity boundary conditions, and it is shown that for a wide range of plasma lengths and cavity mirror reflectivities, the threshold values for instability are approximately those for the temporal problem (waves uniform in space, growth or decay in time). Sample results are calculated numerically for the Raman instability in a typical laboratory plasma. Finally, the physical significance of these results is discussed.

9422 Evidence for profile steepening in laser-irradiated plasmas. Phillion, D.W.; Lerche, R.A.; Rupert, V.C.; Haas, R.A.; Boyle, M.J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **20**: No. 11, 1892-1899(Nov 1977).

Experimental evidence of a steepened electron density profile near critical density has been obtained by studying the light scattered by targets (10-μm thick disks and 100-μm diam glass spherical microshells filled with deuterium and tritium gas) illuminated by linearly polarized, 1.06-μm light. Scale lengths on the order of 1 μm have been inferred both from the polarization of the reflected light and from the azimuthal asymmetry (asymmetry about the beam axis) of the time-integrated scattered light with respect to the laser electric field. Azimuthally asymmetric heating of the microshells targets is indicated both by x-ray micrographs and by the spatial distribution of the plasma blowoff.

9423 Coherent scattering of CO_2 light from ion-acoustic waves. Peratt, A.L.; Watterson, R.L.; Derfler, H. (Max-Planck-Institut fuer Plasmaphysik, D-8046 Garching, Federal Republic of Germany). *Phys. Fluids;* **20**: No. 11, 1900-1910(Nov 1977).

Scattering of laser radiation from ion-acoustic waves in a plasma is investigated analytically and experimentally. The formulation predicts a coherent component of the scattered power on a largely incoherent background spectrum when the acoustic analog of Bragg's law and Doppler shift conditions are satisfied. The experiment consists of a hybrid CO_2 laser system capable of either low power continuous wave or high power pulsed mode operation. A heterodyne light mixing scheme is used to detect the scattered power. The proportionality predicted by the theory is verified by scattering from externally excited acoustic and ion-acoustic waves; continuous wave and pulsed modes in each case. Measurement of the ion-acoustic dispersion relation by continuous wave scattering is also presented.

9424 Interference with, and excitation of ion-acoustic waves by laser light. Peratt, A.L.; Watterson, R.L. (Max-Planck-Institut fuer Plasmaphysik, D-8046 Garching, Federal Republic of Germany). *Phys. Fluids;* **20**: No. 11, 1911-1914(Nov 1977).

The effect of laser light having Gaussian spatial and temporal variations upon ion-acoustic waves is investigated analytically. At high power densities this light can interfere with coherent propagating waves in addition to exciting waves streamers which propagate away from the perturbed region at the ion sound velocity.

9425 Mode conversion and tunneling in an inhomogeneous plasma. Ngan, Y.C.; Swanson, D.G. (Department of Electrical Engineering, University of Southern California, Los Angeles, California 90007). *Phys. Fluids;* **20**: No. 11, 1920-1937(Nov 1977).

A theory is presented describing mode conversion and tunneling in a warm, collisionless, toroidal plasma near the first ion-cyclotron harmonic frequency when the waves are propagating perpendicular to the static magnetic field. The coupling region may be characterized by a fourth-order differential equation with one turning point. Employing the method of Laplace integrals and the method of matched asymptotic expansions, transmission, reflection, and conversion coefficients are calculated assuming a fast wave is incident from either side of the coupling region. For a fast wave incident from the low magnetic field side, transmission, reflection, and conversion occur, while for a fast wave incident from the high magnetic field side, only transmission and conversion occur with no reflection, independent of the thickness of the tunneling layer, which implies complete conversion of the fast wave to the slow wave as the tunneling layer becomes thick. The problem of cavity resonance is discussed.

9426 Drift wave eigenmodes in a torus are not localized by shear. Ross, D.W.; Miner, W.H. (Fusion Research Center, University of Texas at Austin, Austin, Texas 78712). *Phys. Fluids;* **20**: No. 11, 1957-1959(Nov 1977).

The radial equations for the poloidal Fourier components of a drift wave in a torus are solved by a numerical finite element method. It is shown that in the trapped electron regime the solutions are not localized by shear.

9427 Formation of small sparks. Barreto, E.; Jurenka, H.; Reynolds, S.I. (Atmospheric Sciences Research Center, The University at Albany, 1400 Washington Avenue, Albany, New York 12222). *J. Appl. Phys.;* **48**: No. 11, 4510-4520(Nov 1977).

The formation of a small incendiary spark at atmospheric pressure is identified with the transition from a weakly to a strongly ionized plasma. It is shown that initial gaseous ionization produced by avalanches and/or streamers always creates a high-temperature ideal electron gas that can shield the applied voltage difference and reduce ionization in the volume of the gas. The electron gas is collision dominated but able to maintain its high temperature, for times long compared to discharge events, through long-range Coulomb forces. In fact, electrons in the weakly ionized plasma constitute a collisionless independent fluid with a thermodynamic state that can be affected directly by field or density changes. Accordingly, with metal electrodes, cathode spot emission is always associated with the transition to a strongly ionized plasma. Neutral heating can be accomplished in two different ways. Effective dispersal of the electrons from the cathode leads to electron heating dominated by diffusion effects. Conversely, a fast rate of emission or rapid field changes can produce nonlinear wave propagation. It is shown that solitary waves are possible, and it is suggested that some spark transitions are associated with shock waves in the collisionless electron gas. In either the diffuse or nonlinear regime, neutral gas heating is controlled by collisions of ions with isotropic thermal electrons. This interaction is always subsequent to changes in state of the electron gas population. The basic results obtained should apply to all sparks.

9428 Wave-induced transport in the pure electron plasma. DeGrassie, J.S.; Malmberg, J.H. (Department of Physics, University of California at San Diego, La Jolla, California 92093). *Phys. Rev. Lett.;* **39**: No. 17, 1077-1080(24 Oct 1977).

The pure electron plasma is an excellent system in which to study transport across a strong magnetic field. We describe the basic experimental arrangement and report on measurements of transport due to an externally launched diocotron mode.

9429 Landau damping of low- and high-power slow electrostatic waves. Paoloni, F.J.; Motley, R.W.; Hooke, W.M.; Bernabei, S. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **39**: No. 17, 1081-1084(24 Oct 1977).

We have excited waves in a warm plasma and have observed strong absorption when ω/k/sub parallele-italic/, in agreement with the predictions of linear Landau damping. At a certain critical power level, cosistent with the power required to flatten the velocity distibution, the absorption disappears. Above this level we have obtained evidence for the appearance of an enhanced electron tail, in and above the energy range where Landau damping should occur.

9430 Electron acceleration during resonant absorption. DeNeef, P. (Department of Applied Science, University of California, Davis, California 95616). *Phys. Rev. Lett.;* **39**: No. 16, 997-1000(17 Oct 1977).

When an oscillating electric field is applied along a plasma density gradient, an enhanced field is resonantly excited where the electron plasma frequency approximately equals the frequency of the applied field. The measured, time-averaged distribution function of the electrons accelerated by the enhanced field in a plasma-filled capacitor includes a high-energy component that agrees with calculations.

9431 Soliton formation and saturation of decay instability of an electromagnetic wave into two plasma waves. Chen, H.H.; Liu, C.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **39**: No. 14, 881-884(3 Oct 1977).

The soliton formation with its detuning of the resonance is shown to be an important saturation mechanism for the two-plasmon decay instability at the quarter critical density in laser-irradiated plasmas.

9432 Magnetic field generation by resonance absorption of light. Bezzerides, B.; DuBois, D.F.; Forslund, D.W. (Theoretical Division, Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, New Mexico 87545). *Phys. Rev., A;* **16**: No. 4, 1678-1686(Oct 1977).

We consider the self-generated dc magnetic fields due to resonant excitation of plasma waves by intense laser light. From Ampere's law we show that the time scale associated with the growth of the magnetic field is essentially the same as the time scale for the growth of the plasma wave. Further, we obtain a simple expression for the steady-state magnetic fields arising from a steady-state current derived in terms of the high-frequency excited fields. Computer simulations verify the theoretical conclusions on both the time variation and the steady-state value of the magnetic field. Difficulties of earlier calculations based on the so-called stress-tensor approach are discussed, and it is shown that the proper use of this method requires the use of a self-consistent kinetic theory for the plasma which takes into account the convection of momentum out of the resonance region.

9433 Total resonant absorption of electromagnetic radiation in an inhomogeneous plasma. Aliev, Y.M.; Vukovic, S.; Gradov, O.M.; Kirii, A.Y.; Cadez, V. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 326-329(20 Apr 1977).

Total absorption of an electromagnetic wave under conditions of resonance is revealed, with emission of natural oscillations of an inhomogeneous plasma.

9434 Resonant absorption of electromagnetic waves in an inhomogeneous plasma. Zharov, A.A.; Kondrat'ev, I.C.; Miller, M.A. (Radiophysics Research Institute). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 8, 330-332(20 Apr 1977).

It is shown theoretically that synchronited excitation of a quasilocalized mode in an inhomogeneous plasma can account for certain observed properties of electromagnetic radiation absorption. (AIP)

9435 High-current plasma cyclotron maser. Bogdankevich, L.S.; Rukhadze, A.A.; Rukhlin, V.G. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 3, 294-297(Mar 1977).

The excitation of electromagnetic waves in a plasma-filled waveguide by a high-current relativistic electron beam with a nonvanishing transverse velocity is analyzed (plasma cyclotron maser). The resonance conditions for the excitation of waves that propagate across the magnetic field, the frequency spectra of these waves, and their growth rates are determined. It is found that a highly relativistic beam in a plasma-filled waveguide can excite two electromagnetic wave modes with equal probability. These waves are analogous to the ordinary and extraordinary waves in an unbounded plasma. With a nonrelativistic beam, on the other hand, the probability is very high that only the wave analogous to the extraordinary wave will be excited. The steady-state amplitudes of the excited waves and the efficiency of the conversion of beam energy into electromagnetic energy are estimated from the condition for deviation from resonance due to the energy loss of the beam electrons.

9436 Anomalous absorption of electromagnetic waves in a randomly inhomogeneous collisionless magnetoactive plasma. Ryzhov, Y.A. (Gor'kii Radiophysics Research Institute). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 75-79(Jan 1977).

The mechanism whereby normal waves lose energy in a magnetoactive collisionless plasma is considered; this mechanism is connected with excitation of normal scattered waves under conditions when their refractive indices can be infinite. Excitation of quasilongitudinal waves near the resonance directions is effected by the scattering of the waves from the inhomogeneities of the plasma electron density. The case $u=\omega/\text{sub } H/^2/\omega^2<1$, when the extraordinary wave is resonant, is analyzed in the greater detail. This case is of importance for wave propagation in the ionosphere and can be invoked to explain the anomalous absorption of ordinary waves in the ionosphere regions adjacent to the reflection point. A comparative analysis is presented of absorption due to different types of inhomogeneities (isotropic small-scale inhomogeneities and large-scale inhomogeneities elongated along the magnetic field). It is shown that at propagation angles chi close to zero, the integral absorption due to different types of inhomogeneities is the same, whereas as $\text{chi}\sim\pi/2$, only small-scale inhomogeneities are significant. The considered mechanism of wave absorption in a collisionless plasma with fluctuations of the electron density can be used to heat a laboratory plasma by a high-frequency electromagnetic field.

9437 Absorption and reflection of laser radiation by a dispersing high-temperature plasma. Afanas'ev, Y.V.; Demchenko, N.N.; Krokhin, O.N.; Rosanov, V.B. (P. N. Lebedev Institute of Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **45**: No. 1, 90-94(Jan 1977).

The two-dimensional self-consistent problem of absorption and reflection of incident radiation by a dispersing high-temperature plasma is considered. The process of interaction of the radiation with matter is described within the framework of the Maxwell equations for the light-wave field and the gas-dynamical equations with allowance for the electronic thermal conduction. A numerical solution to the indicated equations is presented for a plane plasma layer in a wide range of flux densities and for different laser-pulse durations. The main attention is given to the investigation of the efficiency with which the laser-radiation energy is injected into the plasma. The computations are carried out under the assumption of a bremsstrahlung mechanism of absorption and with allowance for a number of collective processes.

9438 International congress on waves and instabilities in plasmas. Survey lectures. Auer, G.; Cap, F. (eds.). Innsbruck; Universitat Innsbruck (1975). 423p.

From 2. international congress on waves and instabilities in plasmas; Innsbruck, Austria (17 Mar 1975).

Papers on beam-plasma interactions, laser-plasma interactions, transport phenomena in high-temperature confined plasmas, and plasma turbulence induced by strong electric fields are presented. Also included in the symposium are papers on nonlinear wave modulation and plasma cavities, turbulent plasma spectroscopy, plasma waves in space, rf of toroidal plasmas, and mathematical models of plasma and hydrodynamic problems. Particular attention is paid to the development of fusion reactors. Individual items are announced in this issue.

9439 Volny v magnitoaktivnoi plazme. (Waves in magnetoactive plasma). Ginzburg, V.L.; Rukhadze, A.A. Moscow; Izdatel'stvo Nauka (1975). 256p. (In Russian).

The book considers the theory of electromagnetic wave propagation in plasmas. The plasma is viewed as a material medium with both frequency and spatial dispersion. Some of the topics discussed are the electrodynamics of media with spatial dispersion, particle collisions, the permittivity of isotropic and homogeneous plasmas, oscillations and stability of an anisotropic plasma, plasmas in external electric fields, drift oscillations and the problem of magnetic plasma control, and electromagnetic waves in a confined plasma.

9440 Structure of ionizing detonation waves in an electromagnetic field. Barmin, A.A.; Lebedeva, L.N. *Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza;* 98-106(1975). (In Russian).

The structure of ionizing detonation waves in an oblique electromagnetic field is analyzed, assuming that the flow representing the structure is defined by a finite rate of chemical reaction and a finite electrical conductivity. In the case where the chemical reaction rate is much greater than the rate of magnetic energy dissipation, additional relations necessary for the existence of wave structure are derived in explicit form.

FUSION POWER PLANTS

9441 (TRITA-EPP—76-19) **EXTRAP concept.** Lehnert, D. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Nov 1976. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A review is given of a recently suggested axially symmetric, quasi-steady, closed, high-beta confinement system. A toroidal pinch of non-circular cross section is supposed to be immersed in the strong, inhomogenous poloidal vacuum field from a set of ring-shaped conductors, all carrying currents in the opposite direction of the plasma current. Preliminary experiments are reported. This 'EXTRAP' concept is expected to have some important advantages, as compared to magnetic bottles based on a main toroidal field component. Concerning plasma equilibrium, there are closed local and average guiding center orbits, beta values of order unity should become available, there is no magnetic surface splitting limit, cyclotron radiation should be kept at an acceptably low level, and bootstrap operation may become possible. Concerning plasma stability, the system should not become sensitive to magnetic island formation and asymmetries, and the short magnetic connection lengths as well as the strong vacuum field gradients should favour stabilization of flute-type, kink, and other magnetohydrodynamic modes. Concerning reactor technology, high power densities are expected to be reached, superconducting coils should not become necessary, the coil stresses are moderate, and repair and replacement are facilitated by the coil geometry. Before a final judgement can be made on this concept, however, extensive experiments and further theoretical analysis are ndeeded.

9442 **Status of fusion development.** Raeder, J. (Max-Planck Inst fuer Plasmaphys, Munich, Ger). *Kerntechnik;* **19**: No. 6, 253-262(Jun 1977).

The energy balances of a fusion plasma and of complete fusion power plants are briefly presented. Descriptions of different approaches to magnetic confinement and of inertial confinement, and two energy balances typical of these concepts, are given. The status of magnetic confinement physics is then described and the ignition criterion following from the plasma energy balance is taken as a basis to compare the various approaches. Finally, reactor designs, systems studies now under way and the problem fields thereby identified are presented. 88 refs.

PHYSICS AND BLANKET ENGINEERING

9443 (IPP—4/143) **Mechanical performance of the fusion reactor first wall. Pt. 1. Steady-state analysis without irradiation effects.** Daenner, W. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Oct 1976. 82p. Dep. NTIS (US Sales Only), PC A05/MF A01.

This report describes the steady-state analysis of the mechanical performance of the fusion reactor first wall, excluding any type of irradiation effect. Starting from a nuclear power density profile obtained from neutronics/photonics calculations, we calculate the temperature and stress profiles taking into account external radiation heat sources and mechanical stresses due to pressure loads. The problem is solved for plane, cylindrical and spherical geometries and for different conditions of support. As a final step temperature and stress loads are quoted versus the material's time rupture properties. The mathematical procedure results in analytical or numerical solutions which have been programmed for the computer. This programm has been applied to a number of problems the investigation of which should show justification for some special kinds of simplification usually made. After investigating these simplifications, the influence of the pressure load, choice of geometry and condition of support is studied.

9444 (IPP—III/26) **Tokamak limiter with built-in magnetic (Mirnov) probes for temperatures of up to 450°C.** Gernhardt, J.; Berger, H.J.; Groening, D.; Hohenoecker, H.; Karger, F.; Sahner, K.; Schraub, S.; Stadlbauer, J.; Volkenandt, H.; Kukral, H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Aug 1976. 9p. Dep. NTIS (US Sales Only), PC A02/MF A01.

6 figs.; 3 refs.

The design of a material limiter with built-in magnetic (Mirnov) probes is described in this report. These probes are used in Pulsator I for investigations of MHD modes and the horizontal plasma position. The use of the proper material for the coil and connection wire is very important because of the high temperature rise of the limiter during the operation of the machine. The maximum measured limiter temperature was 350° C. The electrical circuit, mode signals m=2 and a soft disruptive instability are shown.

9445 (LA—6942-MS) **Cross-section sensitivity analyses for a Tokamak Experimental Power Reactor.** Simmons, E.L.; Gerstl, S.A.W.; Dudziak, D.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 80p. Dep. NTIS, PC A05/MF A01.

The objectives of this report were (1) to determine the sensitivity of neutronic responses in the preliminary design of the Tokamak Experimental Power Reactor by Argonne National Laboratory, and (2) to develop the use of a neutron-gamma coupled cross-section set in the calculation of cross-section sensitivity analysis. Response functions such as neutron plus gamma kerma, Mylar dose, copper transmutation, copper dpa, and activation of the toroidal field coil dewar were investigated. Calculations revealed that the responses were most sensitive to the high-energy group cross sections of iron in the innermost regions containing stainless steel. For example, both the neutron heating of the toroidal field coil and the activation of the toroidal field coil dewar show an integral sensitivity of about -5 with respect to the iron total cross sections. Major contributors are the scattering cross sections of iron, with -2.7 and -4.4 for neutron heating and activation, respectively. The effects of changes in gamma cross sections were generally an order of 10 lower.

9446 (ORNL/TM—5964) **ORNL fusion power demonstration study: the concept of the cassette blanket.** Werner, R.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 66p. Dep. NTIS, PC A04/MF A01.

The cassette blanket introduces four major improvements in fusion reactor blanket design. These are: (1) the cassette itself which by design furnishes the key unit for simplification of blanket replacement and maintenance and also isolates the lithium moderator from the plasma by enveloping it in the coolant; (2) the concept of blanket zoning, which uses to advantage the fact that radiation damage to structure decreases exponentially with distance. With the use of cassettes in series, only the front fraction of the blanket, the first cassette, need be changed due to damage over the life of the plant; (3) the rectangular blanket concept, which recognizes that blankets must envelop the plasma but need not conform to plasma shape. With this rectangular geometry, cassettes may be installed or removed by simple linear motion between magnet coils; (4) internal tritium recovery, which uses a favorable temperature gradient and "MHD-frozen" lithium to diffuse tritium out of the cassette. Supporting calculations and illustrative cases are provided for these four areas using two coolants: helium and HITEC, a eutectic mixture of inorganic salts (potassium nitrate, sodium nitrate, and sodium nitrite).

9447 **Reduction of particle end losses from linear magnetic fusion devices.** Sinnott, T.; Ahlborn, B. (Department of Physics, The University of British Columbia, Vancouver, British Columbia, Canada V6T 1W5). *Phys. Fluids;* **20**: No. 11, 1956-1957(Nov 1977).

A cold gas blanket of density rho_1 reduces the plasma outflow velocity u_s because of the inertia of the cold gas and the establishment of an internal ablation front by absorption of power W (watt/cm^2). u_s is calculated as function of rho_1 and W.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 8974

9448 (CONF-770842—9) **Superconducting coil design for a tokamak experimental power reactor.** Turner, L.R.; Wang, S.T.; Smelser, P. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

Superconducting toroidal field (TF) and polodial-field (PF) coils have been designed for the proposed Argonne National Laboratory experimental power reactor (EPR). Features of the design include: (1) Peak field of 8 T at 4.2 K or 10 T at 3.0 K. (2) Constant-tension shape for the TF coils, corrected for the finite number (16) of coils. (3) Analysis of errors in coil alignment. (4) Comparison of safety aspects of series-connected and parallel-connected coils. (5) A 60 kA sheet conductor of NbTi with copper stabilizer and stainless steel for support. (6) Superconducting PF coils outside the TF coils. (7) The TF coils shielded from pulsed fields by high-purity aluminum.

9449 (CONF-770842—10) **Results from a model system of superconducting solenoids and phase shifting bridge for pulsed power studies for proposed tokamak EF coils.** Fuja, R.E.; Kustom, R.L.; Smith, R.P. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

A matched pair of superconducting solenoids and a phase-shifting bridge circuit has been constructed to study energy storage and transfer for application to tokamak EF coils. The intrinsically stable solenoids, each with 4 H self-inductance, incorporate sufficient cooling to allow charging at several hundred volts, corresponding to B = 1 T/sec. The three-phase inductor-convertor capacitive bridge

network operating at up to 150 V rms transfers energy reversibly and at controllable rates from the storage coil to the load coil.

9450 (IPP—4/145) **Comparison of some analytically and numerically calculated parameters for toroidal field coils.** Soell, M. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Nov 1976. 28p. Dep. NTIS (US Sales Only), PC A03/MF A01.

In this paper, a comparison is made between toroidal coil parameters calculated analytically and numerically by computer programs. One reason for this comparison is that in the case of good agreement between numerically and analytically calculated parameters one can save computing time especially for parameter studies. As parameters investigated in this work we have chosen the maximum magnetic field, the radial magnetic force per unit length exerted on the conductor and the centering force per coil. The investigations were carried out for circular and D-coils. We also compare the stresses in a superconducting circular coil for which the magnetic volume forces are calculated analytically and numerically.

9451 (WFPS-TME—013) **Structural analysis of TFTR toroidal field coil conceptual design.** Smith, R.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 71p. Dep. NTIS, PC A04/MF A01.

The conceptual design evaluation of the V-shaped toroidal field coils on the Tokamak Fusion Test Reactor has been performed by detailed structural analysis with the finite element method. The innovation provided by this design and verified in this work is the capability to support toroidal field loads while simultaneously performing the function of twist restraint against the device axial torques resulting from the vertical field loads. The evaluations made for the conceptual design provide predictions for coil deflections and stresses. The results are available for the separate effects from toroidal fields, poloidal fields, and the thermal expansion of the coils as well as for the superposition of the primary loads and the primary plus thermal loads.

9452 (WFPS-TME—016) **Structural analysis of equilibrium and ohmic heating coil assemblies for the TFTR.** Chattopadhyay, S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 40p. Dep. NTIS, PC A03/MF A01.

The structural adequacy of the equilibrium and ohmic heating coils and their support systems for the TFTR device has been investigated. The capability of the coils to span ribs of the support structure has been established. The support structure has been found to be effective in resisting the magnetic forces in the coils. The bands encircling the outboard coils and the band tensioning devices have been found to perform adequately. The analysis is based on October 1975 conceptual design.

9453 **Superconducting magnet systems for fusion reactors.** Soell, M. (Max-Planck Inst fuer Plasmaphys, Garching, Ger). *Kerntechnik;* **19**: No. 6, 272-278(Jun 1977).

The present state of superconducting magnet technology is used as a basis for showing the requirements for superconducting magnet systems in possible fusion reactors, particularly tokamak reactor designs. Special problems such as the influence of radiation damage on the properties of the material the magnets, the appearance of large forces and mechanical stresses, the use of suitable cooling methods and safety aspects are discussed. Comparison with tested superconducting magnets show that there exists a wide gap between the requirements of tested superconducting magnets and those of fusion reactors; closing this gap is one of the main objectives of fusion technology. 61 refs.

9454 **Superconductors and their application in fusion reactors.** van der Klein, C.A.M. *Atoomenerg. Haar Toepass.;* **18**: No. 1, 8-18(Jan 1976). (In Dutch).

The magnetisation curve of Type-I (soft) superconductor having two different temperatures is illustrated, and also that for an ideal Type-II (hard) superconductor. Technical parameters are given for a number of superconducting stationary magnetic installations at CERN (the big European hydrogen bubble chamber and omega) at ANL, NAL and BNL. The European program for superconductor technology is outlined and describes the Tokamak experiment and other possibility studies.

9455 **Design of a superconducting toroidal field magnet system for the Argonne Tokamak experimental fusion power reactor.** Purcell, J.; Wang, S.T.; Niemann, R. (Argonne National Lab., IL). pp 29 of In 2nd international conference on plasma science. New York; Institute of Electrical and Electronics Engineers (1975).

From 2. international conference on plasma science; Ann Arbor, MI, USA (14 May 1975).

As part of the Argonne experimental power reactor program a toroidal field coil system has been designed. A practical and sound toroidal coil system that is an integrated part of a Tokamak machine is presented, staying within the limits of a peak field of 8 tesla, the practical maximum of NBTI, in the toroidal coil imposes challenging constraints on the magnet design. The stability of the conductor and the complete coil stability is analyzed in detail. A constant tension coil shape is necessary for the toroidal coils to prevent large bending forces on the conductor and support structure. A new design approach is presented for constant tension coils with a full account for the effect of a finite number of coils on the shape of the constant tension coil.

9456 **Three-dimensional mechanical stresses in toroidal magnets for controlled thermonuclear reactors.** Demichele, D.W.; Darby, J.B. Jr. (Argonne National Lab., IL). pp 558-569 of In Proceedings of the 5th symposium on engineering problems of fusion research. New York; Institute of Electrical and Electronics Engineers (1974).

From 5. symposium on engineering problems of fusion research; Princeton, NJ, USA (5 Nov 1973).

It appears that when the field limits of toroidal superconducting magnets are considered, the mechanical stresses on the coils will be a primary limitation. Two coil geometries have been analyzed; the circular coil toroid similar to the Oak Ridge design, and the "d"-shaped coil similar to the design proposed by the Princeton Plasma-Physics Laboratory. Stresses calculated by a three-dimensional analysis are presented for the coils under normal and abnormal operating conditions. The abnormal condition considered is the unexpected "quench" of an adjacent coil resulting in asymmetric magnetic fields, the three-dimensional magnetic fields, within the current-carrying conductors, were calculated to determine the body forces. A three-dimensional, finite-element elastic stress analysis code, "solid sap," was used to evaluate the resultant mechanical stresses.

9457 **Performance of medium-sized Nb_3Sn coils in He gas up to 17K.** Jackel, H.J.; Kisslinger, J.; Rau, F. (Max-Planck Inst. of Plasmaphysics, Garching, Ger.). pp 582-586 of In Proceedings of the 5th symposium on engineering problems of fusion research. New York; Institute of Electrical and Electronics Engineers (1974).

From 5. symposium on engineering problems of fusion research; Princeton, NJ, USA (5 Nov 1973).

Two medium-sized superconducting coils with stored magnetic energy up to 50 kJ each, made from Nb_3Sn tape, are studied by measuring coil currents and local magnetic field components until the quench occurs. At temperatures above 11°K the quench radial magnetic field approaches the radial penetration field as estimated in a simple model. Local magnetic field measurements appear to show diamagnetic effects in the tape. The correlation of these experiments to problems of the construction of large superconducting coils for toroidal fusion research magnets is discussed, especially with respect to the optimization of coil geometry and the minimization of the number of magnet modules necessary for a torus sector experiment.

POWER SUPPLIES AND CIRCUITRY

9458 (CONF-770801—25) **Results from a model system of superconducting solenoids and phase shifting bridge for pulsed power studies for proposed tokamak EF coils.** Fuja, R.E.; Kustom, R.L.; Smith, R.P. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From Cryogenic engineering conference; Boulder, Colorado, United States of America (USA) (2 Aug 1977).

A matched pair of superconducting solenoids and a phase-shifting bridge circuit has been constructed to study energy storage and transfer for application to tokamak EF coils. The intrinsically stable solenoids, each with 4 H self-inductance, incorporate sufficient cooling to allow charging at several hundred volts, corresponding to B approximately equal 1 T/sec. The three-phase inductor-convertor capacitive bridge network operating at up to 150 V rms transfers energy reversibly and at controllable rates from the storage coil to the load coil.

9459 (WFPS-TME—009) **Six phase rectifier digital computer simulation.** Miller, R.W.; Nichols, J.O. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 66p. Dep. NTIS, PC A04/MF A01.

A digital computer program has been developed for the simulation of a six-pulse converter with a resistance-inductance load. The program calculates the time histories of the voltages and currents on both the ac and dc sides of the rectifier bridges. The grid delay angle is calculated in terms of the load current, supply voltage, and commutating reactance. The program is written in FORTRAN and is executable on the CDC7600 Plotted output of ten variables can be requested. This program is a preliminary effort toward the development of analytical and programming techniques that can be used in the simulation of the twelve-pulse controlled rectifiers in the TFTR toroidal field coil energy conversion system.

9460 **Technological Alfven waves.** Shercliff, J.A. (Univ of Warwick, Coventry, Eng). *Proc. Inst. Electr. Eng. (London);* **123**: No. 10, 1035-1042(Oct 1976).

This paper investigates the applicability of Alfven waves in large homopolar energy-storage devices for use in areas such as fusion technology where up to gigawatt powers may be required for periods of the order of 1 sec. Sodium is proposed for the liquid rotor. A wave device offers the attractive characteristic of delivering constant power into a resistive load, which can be matched to the characteristic impedance of the device. This impedance may be raised by the use of inductive coupling provided current reversal can be tolerated. After a discussion of ideal systems, in which dissipation is neglected, the various sources of energy loss and undesirable 3-dimensional effects (secondary flow) are investigated in order-of-magnitude terms, with reference to the relatively scanty experimental information already available. Hitherto unpublished results by A. Jameson concerning laboratory Alfven waves in sodium are presented. The conclusion is that, even in the largest systems, ohmic effects on the waves cause nontrivial losses, and the advantages of an Alfven-wave system over alternative schemes would have to be very compelling before the formidable technological task of developing large Alfven devices could be undertaken. When the stored kinetic-energy density reaches the higher levels, secondary flow during wave transits may become a major difficulty. 14 refs.

9461 **Inductive energy storage system with capacitive or homopolar transfer.** Thomassen, K.I. (Los Alamos Scientific Lab., NM). pp 444-446 of In Proceedings of the 5th symposium on engineering problems of fusion research. New York; Institute of Electrical and Electronics Engineers (1974).

From 5. symposium on engineering problems of fusion research; Princeton, NJ, USA (5 Nov 1973).

A magnetic energy transfer scheme using a capacitive or inertial storage element is described and its losses are delineated. The system is capable of essentially 100 percent transfer of energy from a superconducting storage coil. The application to the rapid transfer of energy in a toroidal theta pinch system is discussed and component sizes are estimated.

COOLING SYSTEMS

9462 (BNWL—2301) **Requirements for a helium-cooled blanket heat removal system development facility for fusion reactor research.** Sutey, A.M.; Zaloudek, F.R.; Bomelburg, H.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-06-1830. 47p. Dep. NTIS, PC A03/MF A01.

Existing and potential design problems associated with the helium-cooled blanket assemblies of experimental, demonstration and hybrid reactor designs considered in the Magnetic Fusion Energy (MFE) Program were assessed. It was observed that a balanced program of design, analysis and experimentation would be required to develop, verify and qualify these designs and those of related hardware and equipment. To respond to the potential experimental requirements of the first-generation reactors (the EPRs and possibly the hybrid concept), the need for a helium test facility was identified. It was determined that this facility should have the capacity for recirculating 100,000 kg/hr of helium at 70 atm and 600°C and should have 3 MW of electrical power available for simulating neutron heating. No radioactive material or processes should be used to facilitate "hands-on" experimentation and development. The general types of testing anticipated in this facility would include: (1) thermal and coolant flow performance of the blanket and other components in the primary cooling circuit; (2) structural adequacy of the blanket and first wall including vibration considerations; (3) capability for accommodating safety/off-normal conditions. Existing facilities worldwide were surveyed. It was determined that a number of facilities exist in foreign nations for performing the anticipated experiments. However, no large helium gas flow loop exists within the USA. Consequently, it is recommended that a helium thermal-hydraulic blanket test facility be planned and build on a schedule that will meet the unique design development and verification needs of the fusion program. This report provides the rationale and preliminary scoping of the operational characteristics and requirements for such a facility.

FUEL SYSTEMS

REFER ALSO TO CITATION(S) 9174

9463 **Ablation rates of polystyrene microspheres in a θ-pinch plasma.** Smith, D.L.; Kristiansen, M.; Hagler, M.O. (Plasma Laboratory, Department of Electrical Engineering, Texas Tech University, Lubbock, Texas 79409). *J. Appl. Phys.;* **48**: No. 11, 4521-4527(Nov 1977).

The ablation rates of stationary solid polystyrene spheres of 50—150-μm radii exposed to a dense (n/sub e/ ~ 5 x 10^{22} m^{-3}) hot (T/sub e/ < T/sub i/ ~ 120 eV) plasma of 2-μs duration have been measured. Qualitative agreement with recent theoretical scaling laws was obtained. Comparison of the ionization intensities in the ablating neutral pellet material through the first four carbon lines indicate temperatures in the range of 5 eV. Focusing a Q-switched ruby laser on the cloud produces a marked increase in the ionization intensities. The pellet surfaces acquire a fine polish when exposed to a plasma as shown by electron microscopy.

9464 **New lens system using toroidal magnetic field for intense ion beam.** Mohri, A.; Ikuta, K.; Fujita, J. (Nagoya Univ, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. 3, 491-496(Mar 1977).

The use of a toroidal magnetic field as a lens system is proposed for producing an intense ion beam. The characteristics of the lens system are obtained both analytically and numerically. Some examples of ray-trajectories are presented for different focal lengths. The system is applicable to neutral beam injection heating and micro-pellet implosion for nuclear fusion, and to other fields such as ion beam X-ray lasers. 7 refs.

RADIATION HAZARDS

REFER ALSO TO CITATION(S) 8113

9465 (WFPS-TME—024) **Fusion-driven actinide burner design study. Second quarterly progress report.** Chi, J.W.H.; Gold, R.E.; Holman, R.R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Nov 1975. Contract EY-76-C-02-3073. 178p. Dep. NTIS, PC A09/MF A01.

The Second Quarterly Progress Report summarizes the status at the mid-point of the conceptual design effort. The fusion driver continues to pose some of the principal design problems due to the necessity of advancing plasma engineering and technology for long pulse, high duty cycle operation. The development of credible design solutions to these problems is one of the major objectives of the study. The TF and OH coil designs have been modified to provide a more compact arrangement in the nose region of the TF coils and to ensure fully cryostable operation. A unique concept has been developed to effectively shield the TF coils from the poloidal fields. A vacuum vessel concept which separates the functions for sustaining the differential pressure load and for sealing the vacuum system is described. The thickness of the blanket has been decreased to reduce the power density and the actinide inventory. Determination and presentation of actinide depletion characteristics represents a major element thus far in the study and is a principal objective. Evaluation of the changes in the hazard only during irradiation proved to be an inadequate measure of the reduction in long term hazards due to the importance of radioactive daughter products which appear much later in time. Therefore, comparisons have been made of long term decay characteristics before and after irradiation in the actinide burner. It has also been noted that some of the actinides that are produced during irradiation have beneficial applications as radioisotopic power sources. These and other considerations suggest that alternate approaches to assessing the waste management problem be considered to develop a meaningful perspective on long term hazards from the actinides.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 8902, 8968, 9405

9466 (IPP—IV/95) **Initial target experiments with the iodine laser.** Eidmann, K.; Dorn, C.; Sigel, R. (Max-Planck-Gesellschaft zur Foerderung der Wissenschaften e.V., Garching/Muenchen (Germany, F.R.). Projektgruppe fuer Laserforschung). Dec 1976. 9p. (CONF-761025—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From European conference on laser interaction with matter; Palaiseau, France (18 Oct 1976).

An iodine laser with output powers up to 40 GW and energies up to 30 J has been built specifically for laser-plasma experiments. Target laser problems such as prepulses, isolation of the laser against backreflected light and focusibility of the outputbeam are discussed. Maximum intensities up to 10^{15} W/cm^2 are obtained. First reflection data obtained with a plane plexiglas target are presented.

9467 (SAND—77-1549C) **High power magnetically insulated radial diode.** Kuswa, G.W.; Humphries, S. Jr.; Johnson, D.J.; Leeper, R.J.; Freeman, J.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 17p. (CONF-771035—6). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

Several configurations for achieving a spherical focus of centimeter scale are outlined and the possible application to ion beam inertial confinement fusion experiments in the near term is discussed.

9468 (UCRL—79769) **Brillouin scatter in laser-produced plasmas.** Phillion, D.W.; Kruer, W.L.; Rupert, V.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jul 1977. Con-

tract W-7405-ENG-48. 14p. (CONF-770538—3). Dep. NTIS, PC A02/MF A01.

From 7. annual symposium on the anomalous absorption of intense high frequency waves; Ann Arbor, Michigan, United States of America (USA) (18 May 1977).

The absorption of intense laser light is found to be reduced when targets are irradiated by 1.06 μm light with long pulse widths (150-400 psec) and large focal spots (100-250 μm). Estimates of Brillouin scatter which account for the finite heat capacity of the underdense plasma predict this reduction. Spectra of the back reflected light show red shifts indicative of Brillouin scattering.

9469 (UCRL—79793) **Diagnostics developments and applications for laser fusion experiments.** Coleman, L.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Sep 1977. Contract W-7405-ENG-48. 23p. (CONF-770945—1). Dep. NTIS, PC A02/MF A01.

From 11. European conference on laser interaction with matter; Oxford, UK (19 Sep 1977).

Some diagnostics techniques applied to current laser fusion target experiments are reviewed. Specifically, holographic interferometry of target plasmas, coded aperture imaging of thermonuclear alpha-particles and neutron energy spectrum measurements are discussed.

9470 (UCRL—79817) **Use of x-ray imaging on laser fusion experiments.** Boyle, M.J.; Attwood, D.T.; Ceglio, N.M.; Koppel, L.N.; Slivinsky, V.W.; Larsen, J.T.; Storm, E.K.; Price, R.H.; Ahlstrom, H.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1977. Contract W-7405-ENG-48. 26p. (CONF-770945—2). Dep. NTIS, PC A03/MF A01.

From 11. European conference on laser interaction with matter; Oxford, UK (19 Sep 1977).

A variety of x-ray imaging techniques have been used to study the absorption, transport and implosion characteristics of exploding pusher microsphere targets irradiated with 1.06 μm light. Multichannel grazing incidence reflection microscopy, zone plate coded imaging and spatially resolved x-ray spectroscopy have observed the thermal and suprathermal x-ray emission associated with these phenomena. A second generation of x-ray imaging devices, designed for forthcoming high density implosion experiments, including axisymmetric x-ray microscopes and 1- and 2-D crystal line imaging devices, will also be briefly discussed.

9471 **Uniform illumination of spherical laser fusion targets.** Howard, J.E. (University of Wisconsin, Nuclear Engineering Department, Madison, Wisconsin 53706). *Appl. Opt.;* **16**: No. 10, 2764-2773(Oct 1977).

Uniformity of illumination of spherical laser fusion targets is calculated for eight, twelve, and twenty beams arranged according to the symmetry of the Platonic solids. Uniformity is optimized by varying the f/no. of ideal aberration-free lenses, amount of beam overlap, and the shape of the spatial beam profile. The numerical results show twenty-beam illumination to be slightly better than twelve-beam illumination, with eight beams running a poor third. Refractive energy losses due to nonorthogonal illumination and the implications for the design of a practical laser fusion reactor are discussed.

9472 **Spectra and absolute yield of charged particles produced as a result of laser-initiated fusion reactions.** Gus'kov, S.I.; Krokhin, O.N.; Rozanov, V.B. (Inst. of Physics, Moscow). *Kvantovaya Elektron. (Moscow);* **2**: 2315-2324(Oct 1975). (In Russian).

Analytical results are presented for the spectra and absolute yields of charged fusion-reaction products escaping from a laser-produced plasma. It is shown that the size, density, and temperature of the compressed core of a laser-produced plasma can be determined by experimental measurement of the spectra and yields and by use of the present results.

9473 **Some characteristics of CO(sub 2)-laser-induced multiple spark breakdown at pressures up to 11 atm.** Morrison, R.W.; Swail, C. (Carleton Univ, Ottawa, Ont). *J. Appl. Phys.;* **46**: No. 9, 3817-3827(Sep 1975).

A study has been made of the visible breakdown plasma produced by focusing single TEA CO(sub 2) laser pulses 200 nsec wide with salt lenses of 16- and 22-cm focal lengths in argon, helium, neon-helium, and nitrogen at pressures up to 11 atm. The spatial structure of the breakdown plasma as seen by time-integrated photography, and the temporal development, monitored by photon drag observations of the transmitted power pulse, were studied with various gases, pressures, and incident pulse energies. A description of the breakdown process is offered which accounts for many of its features, especially the absence of breakdown in the focal region. 42 refs.

9474 **On the magnitude of the magnetic field produced in a laser plasma.** Nastoyashchii, A.F. *Sov. At. Energy (Engl. Transl.);* **38**: No. 1, 30-32(Jan 1975).

Calculations were carried out showing that the maximum possible magnetic fields occurring in a laser heated plasma are such that the dimensionless ratio (omega)(tau)(sub e) cannot significantly exceed unity and there is no catastrophy for Teller's scheme (laser triggering of a thermonuclear reaction). 11 refs.

9475 **Measurements of spontaneous magnetic fields in laser-produced plasmas.** Schwirzke, F. (New Postgrad Sch, Monterey, Calif). pp 213-235 of In Laser interactions and related plasma phenomena. Vol. 3A. New York; Plenum Press (1974).

From Proceedings of the 3rd workshop on laser interactions and related plasma phenomena; Troy, NY, USA (13 Aug 1973).

A survey is presented of investigations of the dynamics of a laser produced plasma and the dependence of the self-generated magnetic fields on position, time, laser power density, and ambient background pressure. 19 refs.

COMPONENT DEVELOPMENT AND TESTING

9476 (EPRI-ER—533) **Fusion reactor control study. First annual report.** Edelbaum, T.N.; Madden, P.A.; Var, R.E. (Draper (Charles Stark) Lab., Inc., Cambridge, Mass. (USA)). Jul 1977. 68p. Dep. NTIS, PC A04/MF A01.

A study is being conducted of the control and instrumentation requirements of Tokamak experimental power reactors. The project includes the development of digital simulations of Tokamak Experimental Power Reactor (TEPR) behavior. Plasma models for the simulator are being prepared under a companion EPRI contract by Science Applications, Inc. This report documents the first year of work, including a description of the simulator, a discussion of TEPR control requirements, and an analysis of plasma major-radius control.

9477 (LA—6633-MS) **Sputtering erosion of fusion reactor cavity walls.** Bohachevsky, I.O.; Hafer, J.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Dec 1976. Contract W-7405-ENG-36. 30p. Dep. NTIS, PC A03/MF A01.

Devised are functions that describe the empirically and theoretically determined behavior of sputtering coefficients. These functions are used in a computer program that calculates erosion rates and total erosion of surfaces bombarded by ion beams of specified intensity. Presented here are analytic expressions that describe the effects of ion energy and angle of incidence, computational procedures, and results. Results, computed for alpha, triton, deuteron, and heavy-metal ions bombarding niobium, carbon, and iron surfaces indicate that for pellets with heavy metal shell structures sputtering erosion should be carefully considered and properly designed for.

9478 (TRITA-EPP—77-01) **Alpha particle problems in shielded support systems.** Lehnert, B. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Dec 1976. 23p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Alpha particle confinement is considered in the case of internal conductor systems with magnetically shielded supports. The treatment includes problems of energy transfer to the background plasma, the balance between radiation losses and alpha particle heating, mirror confinement in the main poloidal field, the cut-off and shielding conditions at the supports, ambipolar electric fields, wall interaction, and support location. With a proper and technically realizable choice of parameter values, it should become possible to achieve alpha particle heating as well as to manage the reactor technological problems due to alpha particle interaction with the supports.

9479 (WFPS-TME—010) **Structural analysis and optimization procedure of the TFTR device substructure.** Driesen, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 33p. Dep. NTIS, PC A03/MF A01.

A structural evaluation of the TFTR device substructure is performed in order to verify the feasibility of the proposed design concept as well as to establish a design optimization procedure for minimizing the material and fabrication cost of the substructure members. A preliminary evaluation of the seismic capability is also presented. The design concept on which the analysis is based is consistent with that described in the Conceptual Design Status Briefing report dated June 18, 1975

9480 (WFPS-TME—012) **Studies of the permeation and diffusion of tritium and hydrogen in TFTR.** Garber, H.J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 124p. Dep. NTIS, PC A06/MF A01.

This report documents the main features of studies conducted on the permeation and diffusion of tritium and hydrogen through the stainless steel sections comprising the vacuum vessel of TFTR. The overall conclusion of these studies is that tritium releases to the environment resulting from TFTR operations under normal conditions will be very small, less than one curie per year. A basis is described for predicting the magnitudes of the applicable transport

properties for tritium-austenitic stainless steel systems as derived from a survey of the technical literature on tritium transport. The key characteristics of the TFTR vacuum vessel that are involved in the permeation and diffusion calculations are given. Information is given regarding the contemplated plasma scenarios and associated required gas injection quantities. Various issues involved in the bakeout of the vacuum vessel are discussed; focussing principally on the problems associated with in-situ bakeout and related means to reduce outgassing from the TFTR vessel and vacuum pumping system hardware. The anticipated tritium releases are studied considering the diffusion transients.

9481 (WFPS-TME—015) **Thermal analysis of the TFTR vacuum vessel wall protective plate.** Lee, A.Y. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 22p. Dep. NTIS, PC A02/MF A01.

The TFTR vacuum vessel is to be protected with tungsten plates from the effects of neutral beam impingement. A thermal analysis is performed to determine the maximum allowable beam intensity (power per unit area) under normal and faulted operating conditions. In order to permit a faulted pulse, or unattenuated injection, to occur after normal pulse series, the maximum neutral beam energy flux should be below 10 kW/cm^2 depending on the beam design configuration, to prevent the melting of the plates. The analyses were performed using an injection time of 0.5 second and a cycle time of 300 seconds.

9482 **Self-consistent background gas density calculation in a multichambered neutral beam line.** Jong, R.A. (United Technologies Research Center, East Hartford, Connecticut 06108). *J. Vac. Sci. Technol.;* **14**: No. 6, 1303-1306(Nov 1977).

A model for calculating the self-consistent background gas density in a multichamber beam-line system is described. This model is applied to the design of the experiment chamber/beam-line vacuum system for the laser-initiated target experiment at the United Technologies Research Center.

9483 **Transport of deuterium in Nb—1 wt% Zr.** Alire, R.M. (Univ. of California, Livermore). *Nucl. Technol.;* **35**: No. 3, 651-655(Oct 1977).

The diffusion coefficients of D2 in Nb—1 wt% Zr were determined in the range from 923 to 1148 K. A hollow-cylinder model, used as the frame of reference, adequately described the transport of D_2 through the alloy containing oxygen impurities. The diffusion coefficient is temperature dependent and is best described by $D(m^2/s) = 8.5 +- 7 \times 10^{-8} \exp(-48.2 +- 6.7 \times 10^3/RT)$.

9484 **Fusion materials.** Rovner, L.H. (Gen At Co). *Power Eng.;* **81**: No. 7, 61-65(Jul 1977).

A study is made of materials requirements for tokamak nuclear fusion systems. Particular attention is paid to the problem of material erosion from the first wall due to the impingement of high-energy ions from the plasma. It is therefore suggested that a low atomic number material such as carbon or silicon carbide be chosen to interface with the plasma. Other problems discussed include irradiation-induced swelling of material and the use of graphite to moderate the damage. Finally, the problem of radiation-induced resistivity increases in superconducting magnets is discussed.

GENERAL AND MISCELLANEOUS

MANAGEMENT

9485 (ORNL—5171, pp 363) **Education and vocational training.** Fair, M.F.; Turner, J.E. Oct 1976.

In Health Physics Division. Annual progress report for period ending June 30, 1976.

The Faculty Institute in Applied Health Physics started in the summer of 1974 in response to the nation's needs for persons trained at the bachelor's level in health physics technology. Surveys indicate that between 3300 and 6000 new trained technologists will be needed by 1985. They will be required for nuclear power reactors, fuel-cycle operations, nuclear medicine, regulatory activities, and as replacements for currently employed workers. The Faculty Institute program provides support for contacting college officials to make them aware of these forecasts and interest them in instituting undergraduate health physics course work at their institutions. In addition, the program provides support for ten faculty participants from different universities to spend ten weeks during the summer in the Health Physics Division. These participants have access to the staff and the diverse research and field facilities of the Division. They also utilize the facilities of the Special Training Division at ORAU.

9486 (ORNL—5276) **Dynamic interactive manpower planning and analysis program for a matrix organization.** Bullington, V.R.; Cardwell, R.G.; Stephenson, R.L. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

A computerized manpower planning and analysis method used by a large complex research division with a matrix organization is explained. The example used is a research division consisting of 20 functional cost centers working on approximately 100 programs. The mathematical basis for the calculations and details of the computer program used in the system are described, and typical examples are displayed. 4 figures, 1 table.

9487 (UCRL—79539) **Project scheduling and resource leveling: an algorithmic-interactive procedure.** Lim, J.J.; Wells, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1977. Contract W-7405-ENG-48. 7p. (CONF-771005—3). Dep. NTIS, PC A02/MF A01.

From Symposium on systems and decision sciences; Berkeley, California, USA (2 Oct 1977).

A mathematical model of the resource-constrained scheduling problem is presented. An algorithmic-interactive procedure for solving the problem is developed because the combinatorics of the mathematical model prevent an analytical solution. The procedure is shown to be a viable technique when applied to a scheduling and resource allocation problem at Lawrence Livermore Laboratory. 2 figures.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 7932, 7980, 9169, 9314

9488 (ANL—8000(Rev.2)) **Speakeasy-3 reference manual. Level MU. IBM OS/VS version.** Cohen, S.; Pieper, S.C. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 345p. Dep. NTIS, PC A15/MF A01.

Speakeasy is a computer language designed to provide access to information stored in a computer. Ease of use, natural notation, and built-in capabilities for growth are important features of Speakeasy. The language is based on the concepts of arrays and matrices, and processes these as entities; the need for many of the loops necessary in other programing languages is thus eliminated. It has a large vocabulary (over 500 words) of functions and commands in the areas of array manipulation, matrix algebra including eigenanalysis, special mathematical functions, numerical integration and differentiation, statistics, graphics, and character processing. It can be used either in batch mode or interactively. This book is the primary reference manual for the Speakeasy language and presents a nearly complete description of its capabilities. The chapters deal with the use of Speakeasy as a "super desk calculator," the construction and editing of Speakeasy programs, the ability to communicate with other programing languages, the construction of user-written additions to the language, and various other facets of Speakeasy. In addition, a complete listing of the Help Library, which contains brief descriptions of each of the Speakeasy functions or commands, is included. This edition applies to the Mu release of Speakeasy-3, and describes the IBM OS/VS version. 18 figures.

9489 (ANL-AMD-TM—303) **OCOPTR: a derivative free FORTRAN implementation of Davidon's optimally conditioned method.** Davidon, W.C.; Nazareth, L. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 59p. Dep. NTIS, PC A04/MF A01.

A derivative-free implementation of Davidson's Optimally Conditioned Method for unconstrained optimization is described, and computational experience on a set of test problems is given. 3 tables.

9490 (ANL-AMD-TM—306) **DRVOCR: a FORTRAN implementation of Davidon's optimally conditioned method.** Davidson, W.C.; Nazareth, L. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 37p. Dep. NTIS, PC A03/MF A01.

An implementation of Davidon's Optimally Conditioned Method which requires that both the function and its gradient be supplied is discussed. Computational experience on a set of test problems is also described. 3 tables.

9491 (ANL-AMD-TM—307) **Argonne Braille Machine Tape Production Facility user guide.** Foster, R. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 21p. Dep. NTIS, PC A02/MF A01.

In order to use the Argonne Braille Machine, 1/4 inch digital magnetic tapes with both prerecorded formats and Braille data are necessary. It is the function of the Argonne Braille Machine Tape Production Facility to generate these tapes by using data provided by the Argonne Braille Translator, volunteer braillists, etc., as input.

This report gives an overview of the Tape Production Facility and discusses its operation through use of both narratives and examples.

9492 (ANL-AMD-TM—308) **Argonne Tape Production Facility systems descriptions.** Foster, R.; Lidinsky, W. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 64p. Dep. NTIS, PC A04/MF A01.

This memorandum describes the operation of the Tape Production Facility. After a brief overview, first the system hardware and then the system software are described. The software consists of two parts: the systems software for the Tape Production Facility and microcode that executes on a SMS Microcontroller. The Microcontroller and some interface hardware implement a dual incremental digital tape transport controller. Logic diagrams and listings for all software are also given. 8 figures.

9493 (COO—2280-33) **Synthesis of approximation errors.** Bareiss, E.H.; Michel, P. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Computer Sciences). Jul 1977. Contract EY-76-S-02-2280. 149p. Dep. NTIS, PC A07/MF A01.

A method is developed for the synthesis of the error in approximations in the large of regular and irregular functions. The synthesis uses a small class of dimensionless elementary error functions which are weighted by the coefficients of the expansion of the regular part of the function. The question is answered whether a computer can determine the analytical nature of a solution by numerical methods. It is shown that continuous least-squares approximations of irregular functions can be replaced by discrete least-squares approximation and how to select the discrete points. The elementary error functions are used to show how the classical convergence criterions can be markedly improved. There are eight numerical examples included, 30 figures and 74 tables.

9494 (LA—6940-MS) **User's guide for the implementation of level one of the proposed American National Standard Specifications for the information interchange data descriptive file on control data 6000/7000 series computers.** Wiley, R.A.; Benkovita, C.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1976. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A03/MF A01.

This document defines the user interface to an implementation of Level 1 of the proposed American National Standard Specifications for an Information Interchange Data Descriptive File. This implementation is in the form of a set of user-callable subroutines that perform the functions necessary to the creation and processing of these files. A user's guide for this implementation on IBM 360/370 series computer systems is in preparation at Oak Ridge National Laboratory. 7 figures.

9495 (LA—6967-MS) **Computer Science and Services Division semiannual report of the CFF Coordinating Committee.** Morse, N.; Kelso, H.F.; Morrison, J. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 26p. Dep. NTIS, PC A03/MF A01.

The report of the Central Computing Facility (CCF) Coordinating Committee (CCC) describes the short-term goals required to implement the CCF Five-Year Plan. The Committee, composed of the Group Leaders of C-4, C-9, and C-11 and an observer appointed by the C-Division Leader, publishes this report semiannually. This report is intended to guide and inform CCF users, the Director's Office, ERDA, and Division members about significant developments in LASL's computing facilities. 4 figures.

9496 (LA-UR—77-2026) **Experience with the CRAY-1 computer at the Los Alamos Scientific Laboratory.** Dorr, F.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 11p. (CONF-771032—2). Dep. NTIS, PC A02/MF A01.

From **EPRI** seminar) exploring applications of digital parallel processing to power systems analysis problems; Palo Alto, California, USA (4 Oct 1977).

The CRAY-1 computer (Serial No. 1) was installed at the Los Alamos Scientific Laboratory (LASL) on April 1, 1976. This report describes experience with the CRAY-1 since that time. The first six months of the period were spent in a detailed evaluation of the hardware. The machine successfully passed the performance thresholds that had been established, and on October 1, 1976, it became available for productive use. Initial efforts were concentrated on achieving an early production capability for several large codes. In order to achieve this objective, a link was established between the CRAY-1 and CDC 7600 running the Livermore Time-Sharing System (LTSS). This link became operational in December 1976, and security approval was received in January 1977. The first major production code became operational in May 1977, and production usage has increased since that time. An operating system for the CRAY-1 that is tailored to the LASL computing environment is currently being developed. Several smaller-scale computers with extensive software facilities that will support the CRAY-1 are being obtained. 4 figures.

9497 (LBL—5598) **Interactive analysis and display of tabular data.** Benson, W.H.; Kitous, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1977. Contract W-7405-ENG-48. 17p. (CONF-770745—1). Dep. NTIS, PC A02/MF A01.

From 4. annual conference on computer graphic and interactive techniques; San Jose, California, USA (20 Jul 1977).

A program for simple data analysis and report design is described. The design emphasizes flexibility, ease of use, and rapid interactive response. These considerations are discussed in relation to the choices that may be made in the analysis and display design process. The analysis may be directed and monitored at several points, data selection and calibration, binning, choice of data scaling, choice of graphic variable, and scaling of the graphic variable. Table rows and columns can be re-organized by operators such as ranking, sequencing, and grouping, and re-computed from arithmetic combinations of existing rows and columns. Where the raw data represent different cases scored over the same attributes, profile tables can be computed in a systematic fashion. Interactive report design is supported by a variety of page layout and chart annotation directives, which can be used to embellish and adjust the default line, bar, and pie charts. The program can be used interactively as well as driven from a prepared script, and uses a device independent graphic system. Although intended to be used primarily with a graphics terminal, at least half the actual use has been conventional report generation on both alphanumeric and graphic terminals. 1 fig., 1 table.

9498 (LBL—6115(Rev.2)) **Obfuscatory measurement.** Stevens, D.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 25 Jul 1977. Contract W-7405-ENG-48. 15p. (CONF-771116—1). Dep. NTIS, PC A02/MF A01.

From SIGMETRICS/CMG VIII performance conference; Washington, District of Columbia, USA (29 Nov 1977).

"Obfuscatory measurement" is the practice, deliberate or not, of obscuring the true performance of a system through the use of misleading measures. Many of the traditional and widely used measures of computer system performance are obfuscatory: they measure the wrong things, the right things wrongly, or nothing at all. Several obfuscatory measures are considered; those aspects of the system they are thought to measure are contrasted with those that they actually measure; and alternative measures, which are more meaningful to the user community, are suggested. 3 figures, 1 table.

9499 (MLM—2449) **Radio interference with minicomputers and minicomputer peripherals.** Kesling, W.E. (Mound Lab., Miamisburg, Ohio (USA)). 7 Oct 1977. Contract EY-76-C-04-0053. 6p. Dep. NTIS, PC A02/MF A01.

Rf bypass capacitors were added to the Head Position Preamplifier and Servo Power Amplifier on Digital Equipment Corporation (DEC) RK05 DISK TRANSPORTS, and ground straps were installed between all peripheral chassis and the main frame of the minicomputers to eliminate interference that was generated by handheld two-way radios operating in the 165 and 410 MHz ranges. 2 figures.

9500 (ORNL/CSD—26) **Applicability and extendability of Megerlin's method for solving parabolic free boundary problems.** Solomon, A. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 42p. Dep. NTIS, PC A03/MF A01.

The applicability of an analytical approximation procedure of F. Megerlin to a number of free boundary problems is examined. A method for extending the Megerlin procedure to a convergent approximation technique is indicated. Convergence is proved for a particular family of problems, and the implementation of the procedure is demonstrated. 6 tables.

9501 (ORNL/CSD/TM—39) **Comparison of a band matrix method with a block tridiagonal matrix method.** Lynch, S.J.; Hicks, H.R. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

The matrix equation $Av + d = 0$, where A is a block tridiagonal matrix, is solved by two methods: a band matrix solver and a block tridiagonal technique. The computation speed of the two methods is comparable. The method which is actually faster will depend on the details of the optimization of each method. 1 table.

9502 (ORNL/TM—5950) **Contouring on isoparametric surfaces.** Akin, J.E.; Gray, W.H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

A general nonlinear interpolation procedure, which uses standard isoparametric interpolation functions, is presented for contouring on any isoparametric surface.

9503 (SAND—74-0189) **Analysis of one-dimensional algorithms to use with operator splitting in programs for computing wave propagation.** Hicks, D.L.; Lauson, H.S.; Madsen, M.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1975. Contract EY-76-C-04-0789. 63p. Dep. NTIS, PC A04/MF A01.

The analysis of the techniques of wavefitting, movable meshes, controlled entropy production, and an implicit-optional-explicit conservative discrete scheme indicates that these methods can be used to improve the THREEDY wavecode. THREEDY employs operator splitting. Operator splitting decomposes the three-dimensional operator into three one-dimensional operators, and thus simplifies the code. Wavefitting improves the accuracy around wavefronts. A movable mesh alleviates the severe distortion suffered in material coordinates on certain problems. The implicit-optional-explicit scheme is used to avoid the CFL (Courant, Friedrichs, and Lewy) constraint when it is overly restrictive. The explicit option is employed to save time by not iterating to the implicit solution when the CFL restriction happens to be satisfied by the growth restriction timestep. The growth restriction timestep prevents volumes and energies from changing too rapidly and/or going negative. Controlled entropy production avoids the extremes of severe oscillations associated with too little entropy production and excessive smearing with too much entropy increase.

9504 (SAND—77-0618) **QMESH/RHENUM/QPLOT mainframe and plotter conversion: CDC6600 to IBM 360/370 and SC4020 to Calcomp.** Schkade, A.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 7p. Dep. NTIS, PC A04/MF A01.

A code conversion project to modify an existing set of FORTRAN computer programs to run on a different mainframe and to drive a different plotter is discussed. The mainframe conversion was from a CDC6600 to an IBM360; the plotter conversion was from an SC4020 (driven by calls to SCORS library subroutines) to a Calcomp. The changes made because of differences between the FORTRAN compliers were relatively minor. IBM ASSEMBLER source decks were acquired to replace all of the CDC special features (such as ENCODE/DECODE) which have no direct IBM equivalents. The plotter call conversion was more difficult, but was still relatively straightforward. By far the most difficult part of the conversion effort involved converting the file-handling protocol from default-tolerant SCOPE on the CDC6600 to explicit JCL (Job Control Language) on the IBM360; listings of all the IBM deck setups used are included in the Appendix. The programs converted were QMESH, RENUM, QPLOT, RENUM8, and QPLOT8, which together constitute a general-purpose quadrilateral-element mesh generation preprocessor to a variety of finite-element stress analysis programs. 7 figs., 2 tables.

9505 (SAND—77-1030C) **Geometric interpretation of optimal iteration strategies.** Jones, R.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 6p. (CONF-771109—28). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

The relationship between inner and outer iteration errors is extremely complex, and even formal description of total error behavior is difficult. Inner and outer iteration error propagation is analyzed in a variational formalism for a reactor model describing multidimensional, one-group theory. In a generalization the work of Akimov and Sabek, the number of inner iterations performed during each outer serial that minimizes the total computation time is determined. The generalized analysis admits a geometric interpretation of total error behavior. The results can be applied to both transport and diffusion theory computer methods. 1 figure.

9506 (SAND—77-1088) **User/programmer guide for UCMD 64: dumping drawing files to tape.** Robbins, D.K.; Burd, W.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1977. Contract EY-76-C-04-0789. 24p. Dep. NTIS, PC A02/MF A01.

This document describes program UCMD 64--an Applicon AGS/870/880 User Command for selectively dumping drawing files onto magnetic tape, by using an Applicon System.

9507 (SAND—77-1091) **Basic row-column operations with orthogonally linked sparse matrices for use with FORTRAN.** Hanson, R.J.; Wisniewski, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 35p. Dep. NTIS, PC A03/MF A01.

An orthogonally linked data structure is used to represent sparse rectangular matrices. This representation requires four type INTEGER locations and one type REAL location per nonzero entry in the matrix. Operations are presented that perform many of the basic computations required in numerical linear algebra. The operations are available in portable FORTRAN, with the exception of the necessarily operating-system-sensitive "get" and "put" subprogram for the individual records. The package of subprograms manages out-of-memory portions of the matrices as well as the insertion, modification, and deletion of entries. By use of the package, many of the familiar processes of numerical linear algebra, such as solving sparse linear algebraic equations, can be written with a relatively few calls to these subprograms. 2 figures, 3 tables.

9508 (SAND—77-1350) **User/programmer guide for UCMD 43: Zero Core Program.** Burd, W.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 11p. Dep. NTIS, PC A02/MF A01.

UCMD 43, version 1.0, is a MADD system user command that clears core in the PDP-11 equipped with Applicon memory management hardware. The clearing of core, which is performed in a special way, is required whenever the machine is to be powered down for any length of time, such as at the end of the work day or when uncleared personnel need access to the system. The process employed is approved by the security group. Since the program has the ability to determine the available processor core size automatically, it can function on any size configuration without modification.

9509 (SAND—77-1381) **User/programmer guide for UCMD 68: display of command symbols on the graphic display.** Robbins, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 24p. Dep. NTIS, PC A02/MF A01.

This document describes program UCMD 68--an Applicon AGS/870 User Command for displaying a Command Symbol on the Graphic Display.

9510 (SAND—77-8236) **Computer reduction of holographic interferograms.** Jones, H.D. (Sandia Labs., Livermore, Calif. (USA)). Aug 1977. Contract EY-76-C-04-0789. 19p. Dep. NTIS, PC A02/MF A01.

The holographic interferogram gives a powerful technique for the determination of the displacements in a body that has been subjected to stress. The interferogram may be regarded as a contour map of the displacement versus position. To get quantitative information from the interferogram, some sort of data reduction must be done. This is essentially a matter of counting the number of contours crossed while moving from a reference point to a given point on the body. The number crossed is proportional to the displacement at the given point, provided proper care is taken to count up or down according to the direction in which each contour is crossed. While this is a conceptually simple task, it is time consuming if done by the human. However, the task lends itself well to the computer, provided a suitable set of algorithms can be developed to recognize the contours in the interferogram, trace them, enumerate them, and assign displacements to them. This paper describes algorithms used to perform these tasks. In particular, an algorithm is shown for tracing contours in the case that the interferogram image is too large to be kept in the computer memory. While the algorithms were developed to handle the specific problems that arose for the holographic interferogram, they should prove useful for the general contour map reduction problem. 6 figures.

9511 (UCID—17574) **Incomplete Cholesky conjugate gradient method for the STAR (5-point operator).** Greenbaum, A.; Rodrigue, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1977. Contract W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

A method for implementing the Incomplete Cholesky Conjugate Gradient algorithm on the CDC STAR-100 is described. The conjugate gradient method is used to solve the system of equations arising from the differencing of the elliptic partial differential equation (PDE) grad . D(x,y) grad u + cu = f(x,y). The method is implemented by use of a five-point difference approximation the PDE. The method is directly applicable to the nine-point case. 3 tables.

9512 (UCID—17586) **TCD: a program for acquisition of thermocouple and other slow-speed data.** Posehn, M.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Aug 1977. Contract W-7405-ENG-48. 34p. Dep. NTIS, PC A03/MF A01.

A special applications code called TCD is used on the T-DAC computer system at LLL in order to acquire slow-speed data from tests and experiments. This report describes the capabilities and details of operation of TCD. 7 figures.

9513 (UCID—17604) **Interim report: an algebraic approach to the theory of structure.** Hegner, S.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1977. Contract W-7405-ENG-48. 46p. Dep. NTIS, PC A03/MF A01.

Initial ideas on a general algebraic theory of system structure are presented. The author believes that a theory of system structure should be founded on a theory of interconnection. A framework for interconnection theory is given which is based on universal algebra. The adequacy of working with certain substructures of an interconnection algebra is discussed. The idea that an infinite sequence of interconnections mean the same thing as a finite interconnection is briefly considered. Algebraic models of system design are examined. The subject of structure in computer programs provides a useful source of ideas for generalization throughout the work. 92 references. (RWR)

9514 (UCID—17623) **BIHI: bicubic hermite interpolation code.** Dickinson, R.P. Jr.; Carlson, R.E. (California Univ., Livermore

(USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 7p. Dep. NTIS, PC A02/MF A01.

BIHI is a bivariate interpolation code which constructs a piecewise bicubic function that interpolates to a given set of data values arranged over a rectangular grid. 1 figure.

9515 (UCID—30127(Rev.1)(Pt.1)) **PLOTPK: an interactive program that creates graphs and edits pictures. Part 1. User's guide.** Keller, P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Aug 1977. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

PLOTPK is a quick and easy way of plotting data and a flexible means for analyzing it. PLOTPK contains the tools one needs to create two- and three-dimensional graphs and send them to a TMDS screen, RJET printer, or FR80-generated film. A scientist or engineer can use PLOTPK to scan a volume of data, looking for correlations between parameters and visually validating the data. Although PLOTPK does not validate raw data, it does present it in different forms so that the user can evaluate it at a glance--in many cases he is better able to validate the data than is any mathematical subroutine. Because PLOTPK is designed to make it easy for the user to interact with the data, it is not appropriate for production jobs involving hundreds of pictures a day. It is, however, an efficient tool for production in which just a few pictures per day are generated, for in such a case it is quicker to use the PLOTPK program than to write a new one. Part 2 of this report, the "reference document," discusses DO-loops (to make movies), macros for shortcuts, and sorting to help analyze data. 5 figures, 5 tables.

9516 (UCRL—52317) **Documentary of MFENET, a national computer network.** Shuttleworth, B.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 147p. Dep. NTIS, PC A07/MF A01.

Thesis.

The national Magnetic Fusion Energy Computer Network (MFENET) is a newly operational star network of geographically separated heterogeneous hosts and a communications subnetwork of PDP-11 processors. Host processors interfaced to the subnetwork currently include a CDC 7600 at the Central Computer Center (CCC) and several DECsystem-10's at User Service Centers (USC's). The network was funded by a U.S. government agency (ERDA) to provide in an economical manner the needed computational resources to magnetic confinement fusion researchers. Phase I operation of MFENET distributed the processing power of the CDC 7600 among the USC's through the provision of file transport between any two hosts and remote job entry to the 7600. Extending the capabilities of Phase I, MFENET Phase II provided interactive terminal access to the CDC 7600 from the USC's. A file management system is maintained at the CCC for all network users. The history and development of MFENET are discussed, with emphasis on the protocols used to link the host computers and the USC software. Comparisons are made of MFENET versus ARPANET (Advanced Research Projects Agency Computer Network) and DECNET (Digital Distributed Network Architecture). DECNET and MFENET host-to host, host-to-CCP, and link protocols are discussed in detail. The USC—CCP interface is described briefly. 43 figures, 2 tables.

9517 (UCRL—79513) **Generalized message recognition procedure for intelligent minicomputer systems.** Albert, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. 11p. (CONF-771111—1). Dep. NTIS, PC A02/MF A01.

From 1. IEEE international computer software and applications conference; Chicago, Illinois, USA (8 Nov 1977).

A generalized technique for recognizing and evaluating variable-length text streams is described. Messages are treated as patterns of characters, and the use of checksums and stream length are discussed as appropriate describing features. Various examples are provided. The advantages of this technique are its minimal drain on the available memory resources of minicomputers and very fast recognition rates.

9518 (UCRL—80010) **Microcomputer based controller and data acquisition system.** Dalton, W.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1977. Contract W-7405-ENG-48. 5p. (CONF-771101—2). Dep. NTIS, PC A02/MF A01.

From MIDCON electronic show and convention; Chicago, Illinois, USA (8 Nov 1977).

The Lawrence Livermore Laboratory in one of its field operations has developed a microcomputer-based controller/data acquisition system to operate a remote experiment over a single coaxial cable. Data are transmitted in a high-speed burst mode at controlled intervals to achieve a very low duty cycle while maintaining a high throughput. This allows synchronization with other experiments and minimizes interference. Both analog and digital I/O are provided at the control location and at the experiment site. The microcomputer handles CRT data display and hard-copy output at the control location, and can transmit data back to LLL via telephone. The complete system is made with commercially available parts and is suitable for experiments which require remote adjustment to set up, and react in the millisecond time range. 6 figures, 1 table.

9519 **General method for an accurate evaluation of exponential integrals $E_1(x)$, $x>0$.** Sharma, R.R.; Zohuri, B. *J. Comput. Phys.;* **25**: No. 2, 199-204(Oct 1977).

A series expansion is given to enable one to calculate $E_1(\alpha)$ with extremely high accuracy for any value of α.(AIP)

9520 **Stability and semipositivity of real matrices.** Berman, A.; Ward, R.C. (Technion Israel Inst. of Tech., Haifa). *Bull. Am. Math. Soc.;* **83**: No. 2, 262-263(Mar 1977).

The interrelations of various degrees of stability and semipositivity are described for real square matrices. 24 distinct classes are found.

9521 **Kalman filtering applied to statistical forecasting.** Morrison, G.W. (Oak Ridge National Lab., TN); Pike, D.H. *Manage. Sci.;* **23**: No. 7, 768-774(Mar 1977).

The use of the Kalman Filter in a certain class of forecasting problems is described. The time series is assumed to be modeled as a time-varying mean with additive noise. The mean of the time series is assumed to be a linear combination of known functions. The coefficients appearing in the linear combination are unknown. Under such assumptions, the time series can be described as a linear system with the state vector of the system being the unknown parameters and present value of the mean of the process. The Kalman filter can be used under these circumstances to obtain an "optimal" estimate of the state vector. One of the distinct advantages of the Kalman filter is that time-varying coefficients can be permitted in the model. Examples using the Kalman filter in forecasting are presented.

9522 **Univalent functions and the Riemann mapping theorem.** Garabedian, P.R. (New York Univ.). *Proc. Am. Math. Soc.;* **61**: No. 2, 242-244(Dec 1976).

A proof of the Riemann mapping theorem is given that depends on variational formulas for univalent functions. The method of proof can be used to simplify the derivation of the ordinary differential equation for extremal univalent functions given by Schiffer in 1938 [Proc. London, Math. Soc., 44, 432-449].

9523 **Gaussian filters for determining group velocities.** Denny, M.D.; Chin, R.C.Y. (Univ. of California, Livermore). *Geophys. J. R. Astron. Soc.;* **45**: 495-525(1976).

The problem of filtering dispersed wavetrains by Gaussian filters is examined. Asymptotic expressions for small bandwidths are obtained for the centroid and for the variance of the filtered signal about its centroid. The forms of the expressions suggest the use of an extrapolation algorithm to estimate the group arrival time. An optimal filter is introduced to aid in selecting a set of corresponding pairs of centroid and bandwidth values for use in the algorithm. For a finite time series, only those pairs whose variances are well within the length of the time series are considered. In this way, the estimated group arrival times are consistent with the information content of the data and are independent of the data extension technique. The method is applied to both synthesized and real signals. The corresponding errors in the group velocity are less than 0.1 and 2 percent, respectively. 14 figs., 4 tables.

9524 **Subspace selection algorithms to be used with the nonlinear projection methods in solving systems of nonlinear equations.** Georg, D.D. (Colorado State Univ., Fort Collins); Keller, R.F. *Comput. Math. Appl.;* **2**: 225-232(1976).

The nonlinear projection methods are minimization procedures for solving systems of nonlinear equations. They permit reevaluation of n/sub k/, 1 less than or equal to n/sub k/ less than or equal to n, components of the approximate solution vector at each iteration step, where n is the dimension of the system. At iteration step k, the reduction in the norm of the residue vector depends upon the n/sub k/ components which are reevaluated. These n/sub k/ components are obtained by solving a linear system. Two algorithms are presented for determining the components to be modified at each iteration of the nonlinear projection method; the use of these algorithms is compared to Newton's method. The computational examples demonstrate that Newton's method, which reevaluates all components of the approximate solution vector at each iteration, can be accelerated by using the projection techniques. 5 tables.

9525 (UCRL-Trans—11277) **Evaluation criteria for classifiers for automatic spectra interpretation (pattern recognition).** Rotter, H.; Varmuza, K. Translated from *Org. Mass Spectrom.;* **10**: No. 10, 874-884(1975). 18p. Dep. NTIS, PC A02/MF A01.

In recent years numerous methods of pattern recognition have been tested for automatic interpretation of physicochemical data. Classifiers have been used successfully, especially with low-resolution mass spectra. However, judgement of spectral classifiers ("percentage of correctly classified spectra") was often mathematically insufficiently defined. In this paper basic principles of the

probability theory and information theory are used to derive objective criteria for binary classifiers. A classifier is an algorithm that uses a pattern vector (mass spectrum) and a priori probabilities for the classes (chemical structures) to which this vector belongs; the classification results are a posteriori probabilities for the classes. Predictive abilities for both classes or the information gain are suitable, objective criteria to compare classifiers. Mathematical formulas are given and explained by examples from mass spectrometry. 4 figures.

9526 Polyalgorithm with limited memory occupation suitable for minimizing non-linear functions in many variables. Spedicato, E. (Centro Informazioni Studi Esperienze, Milan). *Riv. Inf.;* **4**: No. 2, 199-206(1974). (In Italian).

The CONGC program for minimizing non-linear functions in many variables, based on quasi-Newtonian methods, is given. (JSR)

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 9488

9527 (HEDL-SA—1193) **Information storage and retrieval system at Westinghouse Hanford Company Hanford Engineering Development Laboratory (HEDL).** Theo, M.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1977. Contract EY-76-C-14-2170. 33p. (CONF-770599—1). Dep. NTIS, PC A03/MF A01.

From National Micrographics Association; Dallas, Texas, USA (17 May 1977).

The information storage and retrieval system developed at Westinghouse--Hanford is described. It will be able to store over two million documents on line. The system uses an interactive minicomputer to search for keyworded documents. Documents of interest can be displayed on CRTs or printed on microfilm reader—printers. 31 figures. (RWR)

9528 (LBL—6164) **Automatic document classification based on expert human decisions.** Cahn, D.F.; Herr, J.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1 Mar 1977. Contract W-7405-ENG-48. 23p. (CONF-770815—1). Dep. NTIS, PC A02/MF A01.

From International joint conference on artificial intelligence; Cambridge, Massachusetts, United States of America (USA) (22 Aug 1977).

Machine formation and augmentation of technical information libraries is a provocative and immediately useful application of artificial intelligence. Automatic entry, organization, and retrieval of bibliographic references, and the translation en masse of entire collections of such references from one classification system to another, pose a well-defined problem calling for associative processing of contextually linked quanta of information. Measured human expertise in these tasks provides both a yardstick for machine performance and an initial core upon which a dynamic knowledge base can be built for the machine, using incremental learning techniques. In order to identify parameters affecting this type of classification task, several variations of conditional probabilistic and discriminant-based automatic document classification programs were constructed, and their performance against manual human document entry over several technical information data bases in the energy field were compared. With statistical correspondence between machine and manually generated classifications over fairly extensive document sets as the prime performance yardstick, in a 35 category selection environment, systems emulated human classification decisions with 60 to 94% accuracy; in binary decisions, a simulation accuracy of up to 97% was achieved. Through analysis of the algorithms that performed at various levels within this range, and, in particular, through analysis of common characteristics of the document cases in which correspondence failed, it has been possible to isolate several key parameters that regulate performance in systems of this sort and to gain some understanding of the mechanisms used by human experts in performing these types of classification task.

9529 (UCRL—80146) **Scientific data base management at Lawrence Livermore Laboratory: needs and a prototype system.** Birss, E.W.; Jones, S.E.; Ries, D.R.; Yeh, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1977. Contract W-7405-ENG-48. 14p. (CONF-771062—1). Dep. NTIS, PC A02/MF A01.

From OECD/NEA working group on nuclear information; Berkeley, California, USA (5 Oct 1977).

Lawrence Livermore Laboratory (LLL), with such diverse data applications as material compatibility, laser fusion, magnetic fusion, test, equation of state, weather, environmental and demographic data, has an acute need for a Scientific Data Base Management System (SDBMS). The large volume of data, the numeric values within an epsilon of accuracy, the unknown data relationships, the changing requirements, coupled with the overall goal of extracting new intelligence from the raw data, dictate a data base system tailored toward scientific applications. Such an SDBMS should support scientific data types, a relational end user view, an interactive user language, interfaces to graphical and statistical packages, a programing language interface, interfaces to existing facilities, extensibility, portability, and use in a distributed environment. Addressing these needs, LLL began a project to develop a scientific data base management system. A prototype was implemented which uses a relational algebraic interactive user language. The software consists of a macro processor, a parser, a parse tree generator, a parse tree interpreter, semantic routines, and data base access routines. Currently, the data base access routines utilize a CODASYL data base system for data storage. 4 figs.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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3736	3:9346	Dep. NTIS (US Sales Only), PC A02/MF A01
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3943	3:8345	Dep. NTIS (US Sales Only), PC A02/MF A01
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50(Rev.1)	3:8449	Combustion Engineering, Inc., Windsor, CT
CENPD-		
256	3:8335	Combustion Engineering, Inc., Windsor, CT
CONF-7506170-	(NASA earth resources survey symposium, Houston, Texas, USA, Jun 1975)	
1	3:8240	Dep. NTIS (US Sales Only), PC A02/MF A01
CONF-7506174-	(Annual congress of the Brazilian Association of Metals, Rio de Janeiro, Brazil, 20 Jun-4 Jul 1975)	
1	3:8776	*See* IEA-451
CONF-760359-	(Reactor meeting, Duesseldorf, German, Federal Republic of (F.R. Germany), 30 Mar 1976)	
6	3:8412	*See* BNWL-tr-265
CONF-760488-	(Conference on improving efficiency and performance of HVAC equipment and systems for commercial and industrial buildings, Lafayette, Indiana, United States of America (USA), 12 Apr 1976)	
P1	3:8638	Purdue Research Foundation (1976).
P2	3:8656	Purdue Research Foundation (1976).
CONF-7604139-	(1. international petrochemical conference, San Antonio, Texas, USA, 4-6 Apr 1976)	
3	3:7831	*See* IPC-76-42
CONF-7604141-	(Conservation of resources symposium, Glasgow, UK, 5-9 Apr 1976)	
	3:8572	Chemical Society (1976). $12.00
CONF-7606139-	(4. Indo-German seminar on operation of nuclear power plants, Julich, German, Federal Republic of (F.R. Germany), 29 Jun-2 Jul 1976)	
	3:8502	*See* Juel-Conf-21
CONF-760858-	(Symposium on zirconium nuclear industry, Quebec, Canada, 10-12 Aug 1976)	
3	3:8800	*See* TRG-Report-2949(R)
CONF-7608108-	(UNESCO/WMO solar energy symposium, Geneva, Switzerland, 30 Aug-3 Sep 1976)	
1	3:8135	Dep. NTIS (US Sales Only), PC A02/MF A01
CONF-760958-	(3. international symposium of plasma physics on heating in torodial devices, Varenna, Italy, 6-17 Sep 1976)	
11	3:9346	*See* CEA-CONF-3736
CONF-7609150-	(IAEA international training course on nuclear power project planning and implementation, Karlsruhe, F.R. Germany, 6 Sep 1976)	
32	3:8477	*See* AED-Conf-76-660-021
CONF-761025-	(European conference on laser interaction with matter, Palaiseau, France, 18-22 Oct 1976)	
10	3:9466	*See* IPP-IV/95
CONF-761039-	(Two-phase flow and heat transfer symposium, Fort Lauderdale, Florida, United States of America (USA), 18-20 Oct 1976)	
	3:8937	Hemisphere Publishing Corp., Washington, DC, $35.00
CONF-7610108-	(Symposium of the German Solar Energy Society, Stuttgart, German, Federal Republic of (F.R. Germany), 22 Oct 1976)	
1	3:8133	*See* AED-Conf-76-521-001
CONF-761103-	(ANS winter meeting, Washington, District of Columbia, United States of America (USA), 15-19 Nov 1976)	
31	3:8392	*See* HEDL-SA-897
CONF-761166-	(2. symposium on research applied to national needs, Washington, District of Columbia, United States of America (USA), 7-9 Nov 1976)	
1	3:8192	*See* LBL-5960
CONF-761187-	(Annual meeting of the Congress of Cities National League of Cities, Denver, Colorado, USA, 29 Nov 1976)	
1	3:8564	Washington University (1976).
CONF-770112-	(Proceedings of ERDA solar photovoltaic program, San Diego, California, United States of America (USA), 18-20 Jan 1977)	
	3:8138	Dep. NTIS, PC A99/MF A01
CONF-770148-	(1. annual ERDA battery contractors coordination meeting, Germantown, Maryland, USA, 27-28 Jan 1977)	
	3:8550	Dep. NTIS, PC A16/MF A01
CONF-770239-	(The molecular basis of cell-cell interaction (symposium), San Diego, California, USA, 14-18 Feb 1977)	
1	3:9047	*See* COO-4159-01
CONF-770249-	(Seminar on pulsed neutron uranium borehole logging with prompt fission neutrons and neutron tube technology for PFN logging equipment, Albuquerque, New Mexico, USA, 24 Feb 1977)	
	3:8053	*See* SAND-77-0300
CONF-770402-	(The US-USSR Steering Committee for cooperation in MHD, Washington, District of Columbia, United States of America (USA), 13-21 Apr 1977)	
6	3:8271	Dep. NTIS, PC A02/MF A01
CONF-770409-	(4. congress of the International Radiation Protection Agency, Paris, France, 24-30 Apr 1977)	
10	3:9030	Dep. NTIS, PC A02/MF A01
CONF-770430-	(4. international symposium on automotive propulsion systems, Washington, District of Columbia, United States of America (USA), 17-22 Apr 1977)	
20	3:8745	*See* UCRL-79154
CONF-770505-	(International conference on nuclear power and its fuel cycles, Salzburg, Austria, 2-13 May 1977)	
211(trans)	3:8099	*See* BNWL-tr-263
CONF-770510-	(American Chemical Society meeting, Montreal, Canada, May 1977)	
12	3:8093	*See* MLM-2437(OP)
CONF-770527-	(2. international conference on electrostatic accelerator technology, Strasbourg, France, 24-27 May 1977)	
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CONF-770538-	(7. annual symposium on the anomalous absorption of intense high frequency waves, Ann Arbor, Michigan, United States of America (USA), 18-20 May 1977)	
3	3:9468	*See* UCRL-79769
CONF-770599-	(National Micrographics Association, Dallas, Texas, USA, 17-20 May 1977)	
1	3:9527	*See* HEDL-SA-1193
CONF-770641-	(Conference on radiation effects in breeder reactor structural materials, Scottsdale, Arizona, United States of America (USA), 19-23 Jun 1977)	
12	3:8393	*See* HEDL-SA-1167
CONF-770645-	(4. Rochester conference on coherence and quantum optics, Rochester, New York, United States of America (USA), 8-10 Jun 1977)	
2	3:9173	*See* LBL-6918
CONF-770652-	(3. annual underground coal conversion symposium, Fallen Leaf Lake, California, United States of America (USA), 6-9 Jun 1977)	
8	3:9028	*See* UCRL-79867

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CONF-770656-		(Annual meeting of the Institute of Nuclear Materials Management, Washington, District of Columbia, United States of America (USA), 29 Jun-1 Jul 1977)
26	3:8112	*See* SAND-77-0400
CONF-770687-		(The American Society of Mass Spectrometry, Washington, District of Columbia, USA, 2 Jun 1977)
1	3:8464	*See* HEDL-SA-1154
CONF-770694-		(U.S. Japan exchange meeting, Sunnyvale, California, USA, 27-28 Jun 1977)
1	3:8465	*See* HEDL-SA-1286
CONF-770696-		(International conference on neutrino physics and neutrino astrophysics, Elbrus, USSR, 18-24 Jun 1977)
1	3:9204	*See* LBL-6728
CONF-770708-		(Thermal reactor safety meeting, Sun Valley, Idaho, United States of America (USA), 31 Jul-5 Aug 1977)
15	3:8499	*See* GA-A-14277
16	3:8487	Dep. NTIS, PC A03/MF A01
CONF-770718-		(Symposium on actions of physical and chemical mutagens on the somatic chromosomes of man, Edinburgh, United Kingdom of Great Britain and Northern Ireland (UK), 7-8 Jul 1977)
3	3:7920	Dep. NTIS, PC A02/MF A01
CONF-770720-		(22. annual meeting of the Health Physics Society, Atlanta, Georgia, USA, 3-8 Jul 1977)
2	3:8956	*See* UCRL-78946
CONF-770745-		(4. annual conference on computer graphic and interactive techniques, San Jose, California, USA, 20-22 Jul 1977)
1	3:9497	*See* LBL-5598
CONF-770801-		(Cryogenic engineering conference, Boulder, Colorado, United States of America (USA), 2-5 Aug 1977)
25	3:9458	Dep. NTIS, PC A02/MF A01
CONF-770807-		(4. international conference on structural mechanics in reactor technology, San Francisco, California, United States of America (USA), 15-19 Aug 1977)
35	3:8457	Dep. NTIS, PC A02/MF A01
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49	3:8490	Dep. NTIS, PC A03/MF A01
CONF-770815-		(International joint conference on artificial intelligence, Cambridge, Massachusetts, United States of America (USA), 22-26 Aug 1977)
1	3:9528	*See* LBL-6164
CONF-770817-		(International seminar on containment of fast breeder reactors, San Francisco, California, USA, 22-23 Aug 1977)
2	3:8491	Dep. NTIS, PC A02/MF A01
3	3:8492	Dep. NTIS, PC A02/MF A01
4	3:8493	Dep. NTIS, PC A02/MF A01
5	3:8494	Dep. NTIS, PC A02/MF A01
CONF-770822-		(American Nuclear Society meeting, Chattanooga, Tennessee, USA, 8-10 Aug 1977)
6	3:8461	Dep. NTIS, PC A04/MF A01
CONF-770842-		(6. international conference on magnet technology, Bratislava, Czechoslovakia, 29 Aug-2 Sep 1977)
9	3:9448	Dep. NTIS, PC A02/MF A01
10	3:9449	Dep. NTIS, PC A02/MF A01
13	3:8974	*See* LBL-6716
CONF-770843-		(International thermal expansion symposium, Winnipeg, Canada, 29-31 Aug 1977)
1	3:8785	*See* SAND-77-0626C
CONF-770849-		(Microprobe analytical society meeting, Boston, Massachusetts, USA, 16-24 Aug 1977)
1	3:7861	*See* LA-UR-77-1870
CONF-770856-		(ASNT conference, Wilmington, Delaware, USA, 2 Aug 1977)
1	3:8349	*See* HEDL-SA-1274
CONF-770860-		(5. meeting of the international research group for carcino embryonic proteins, Copenhagen, Denmark, 6-9 Aug 1977)
1	3:9038	Dep. NTIS, PC A02/MF A01
2	3:9039	Dep. NTIS, PC A02/MF A01
CONF-770862-		(International symposium on microbial ecology, Dunedin, New Zealand, 22-26 Aug 1977)
1	3:7886	Dep. NTIS, PC A04/MF A01
CONF-770902-		(Specialists meeting on reactor noise, Gatlinburg, Tennessee, United States of America (USA), 19-23 Sep 1977)
1	3:8322	Dep. NTIS, PC A02/MF A01
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CONF-770903-		(ASME energy technology conference on composites in pressure vessels and piping, Houston, Texas, United States of America (USA), 18-22 Sep 1977)
5	3:8939	*See* KAPL-P-4056
CONF-770920-		(JOWOG-28 conference, Aldermaston, Reading, UK, 20-22 Sep 1977)
3	3:8815	*See* SAND-77-1256C
CONF-770922-		(Photovoltaics solar energy conference, Luxembourg, Luxembourg, 27-30 Sep 1977)
2	3:8171	Dep. NTIS, PC A02/MF A01
CONF-770929-		(Seminar on HTGR safety technology, Upton, New York, USA, 15-16 Sep 1977)
6	3:8346	Dep. NTIS, PC A02/MF A01
7	3:8506	*See* LA-UR-77-1994
8	3:8483	*See* BNL-23196
CONF-770931-		(7. international conference on atomic collisions in solids, Moscow, F.R. Germany, 19-23 Sep 1977)
1	3:9169	Dep. NTIS, PC A02/MF A01
CONF-770934-		(8. international technical meeting on air pollution modeling and its application, Louvain-la-Neuve, Belgium, 20-23 Sep 1977)
1	3:9071	*See* UCRL-79428
CONF-770939-		(3. power plant dynamics, control and testing symposium, Knoxville, Tennessee, USA, 7-9 Sep 1977)
2	3:8450	Dep. NTIS, PC A02/MF A01
CONF-770940-		(Symposium on the production and neutralization of negative hydrogen ions and beams, Upton, New York, USA, 26-30 Sep 1977)
3	3:8970	*See* LA-UR-77-2113
CONF-770941-		(ASNT conference, Richland, Washington, USA, 14 Sep 1977)
1	3:8349	*See* HEDL-SA-1274
CONF-770945-		(11. European conference on laser interaction with matter, Oxford, UK, 19-23 Sep 1977)
1	3:9469	*See* UCRL-79793
2	3:9470	*See* UCRL-79817
CONF-770948-		(SNEAP conference, Los Alamos, New Mexico, USA, 26-28 Sep 1977)
1	3:8954	Dep. NTIS, PC A02/MF A01
CONF-770953-		(Concentrating solar collector conference, Atlanta, Georgia, USA, 26-28 Sep 1977)
2	3:8136	*See* SAND-77-1521C
CONF-770963-		(2. international symposium on polynuclear aromatic hydrocarbons, Columbus, Ohio, USA, 27-28 Sep 1977)
1	3:7859	Dep. NTIS, PC A03/MF A01
CONF-770970-		(EPA/ERDA symposium on high temperature/pressure particulate control, Washington, District of Columbia, USA, 20-21 Sep 1977)
1	3:7879	*See* SAND-77-8707
CONF-771005-		(Symposium on systems and decision sciences, Berkeley, California, USA, 2-4 Oct 1977)
3	3:9487	*See* UCRL-79539
CONF-771012-		(5. ERDA compatibility meeting, Miamisburg, Ohio, USA, 4-6 Oct 1977)
1	3:8763	*See* SAND-77-1237C
CONF-771029-		(7. symposium on fusion research project, Knoxville, Tennessee, USA, 25-29 Oct 1977)
20	3:8957	*See* UCRL-79721
CONF-771031-		(21. conference on analytical chemistry in energy technology, Gatlinburg, Tennessee, USA, 4-6 Oct 1977)
6	3:8985	Dep. NTIS, PC A03/MF A01
CONF-771032-		(EPRI seminar: exploring applications of digital parallel processing to power systems analysis problems, Palo Alto, California, USA, 4-7 Oct 1977)

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1	3:8349	*See* HEDL-SA-1274
CONF-771035-	(2. international topical conference, Ithaca, New York, USA, 3-5 Oct 1977)	
3	3:8969	*See* SAND-77-1365C
5	3:8968	*See* SAND-77-1324c
6	3:9467	*See* SAND-77-1549C
11	3:8960	*See* UCRL-79958
CONF-771036-	(2. ASTM-EURATOM symposium on reactor dosimetry: dosimetry methods for fuels, cladding and structural materials, Palo Alto, California, USA, 2-7 Oct 1977)	
3	3:8462	Dep. NTIS, PC A02/MF A01
CONF-771045-	(8. annual conference on environmental toxicology, Dayton, Ohio, USA, 4 Oct 1977)	
1	3:7921	Dep. NTIS, PC A02/MF A01
CONF-771051-	(ERDA photovoltaics advance materials review meeting, Denver, Colorado, USA, 4-6 Oct 1977)	
1	3:8172	Dep. NTIS, PC A02/MF A01
CONF-771062-	(OECD/NEA working group on nuclear information, Berkeley, California, USA, 5-7 Oct 1977)	
1	3:9529	*See* UCRL-80146
CONF- 101-	(MIDCON electronic show and convention, Chicago, Illinois, USA, 8-10 Nov 1977)	
2	3:9518	*See* UCRL-80010
CONF-771102-	(20. annual AICHE meeting, New York, New York, USA, 13-17 Nov 1977)	
6	3:8109	*See* Y/OWI/TM-25
CONF-771108-	(Post accident heat removal information exchange meeting, Chicago, Illinois, USA, 2-3 Nov 1977)	
1	3:8524	*See* SAND-77-1413C
CONF-771109-	(ANS winter meeting, San Francisco, California, USA, 27 Nov-2 Dec 1977)	
5	3:8471	*See* SAND-77-1015C
7	3:8514	*See* SAND-77-1016C
8	3:9316	*See* UCRL-79761
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1	3:9517	*See* UCRL-79513
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1	3:9498	*See* LBL-6115(Rev.2)
CONF-771120-	(Winter annual meeting of the American Society of Mechanical Engineers, Atlanta, Georgia, USA, 27 Nov-2 Dec 1977)	
1	3:8730	*See* CONS/1011-18
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October 1977

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